National Aeronautics and Space Administration

Commercial Crew Program
John F. Kennedy Space Center

CCT- PLN-2000
Revision: B-3

NASA Crew Transportation System Certification Plan

Original signed by *2/6/2022*
Joseph "Steve" Stich
Manager, Commercial Crew Program

Original signed by *1/21/2022*
Joel R. Montalbano
Manager, International Space Station Program

Not Export Controlled

Record of Revision/Changes

Revision	Description	Date
B-3	Export Control Marking removed for STI and updated from HEOMD to SOMD.	**3/31/2022**
B-2	Revised Appendix F to accurately capture Cert CELL sign offs as implemented in 2020 for CTS Certification.	**12/1/2021**
B-1	Revised to replace all Dissenting Opinion to Formal Dissent per the Associate Administrator's memorandum of June 18, 2020 and updated EAR marking.	**1/22/2021**
B	Revised per CR-0280: Updates include incorporation of CELL planning activities and agency meetings to ensure alignment with HEOMD-CSD-10001 and CCT-PLN-1000.	**12/4/2017**
A	Revised per CR-0229: Updates Certification strategy and implementation approach. Removes content addressed in other Program documents and incorporates Certification Statements, etc.	**3/7/2016**
Basic	NASA Crew Transportation System Certification Plan approved by PCB on 9/5/2013; approved by JPRCB on 9/6/2013; signatures completed on 9/8/2013.	**9/8/2013**

TABLE OF CONTENTS

1.0 Purpose

NASA Crew Transportation System (CTS) Certification is the authorization granted by the Agency that allows the use of a Commercial Provider's CTS to transport NASA Crew to and from the ISS. The CTS Certification decision is made by the NASA Associate Administrator based on the comprehensive assessment of the Certification Review Board and recommendations from the CCP and ISS Program Managers and the NASA Associate Administrator of Space Operations Mission Directorate. The Commercial Provider is responsible for developing and executing its plan for certifying the CTS. The Commercial Crew Program (CCP) with the International Space Station (ISS) Program must substantiate the Commercial Provider's certification assertion of compliance with NASA requirements and NASA Crew safety.

NASA CTS Certification is the approval of the Commercial Provider's evidence of:

- Compliance with the technical management processes requirements covered in *Crew Transportation Technical Management Processes* (CCT-PLN-1120)
- Compliance to the technical requirements in *ISS Crew Transportation and Services Requirements* (CCT-REQ-1130) and *ISS to Commercial Orbital Transportation Services (COTS) Interface Requirements Document (IRD)* (SSP 50808)
- Adherence to the technical standards in *Crew Transportation Technical Standards and Design Evaluation* (CCT-STD-1140) and the operational standards in *Crew Transportation Operations Standards* (CCT-STD-1150)

1.1 Purpose

This *NASA CTS Certification Plan* (CCT-PLN-2000) defines the Certification process for NASA activities for CTS Certification. The Plan also defines the CCP products and certification statements required to support a recommendation for CTS Certification and the associated roles and responsibilities. This document also defines the requirements for the integrated packages required as part of the CCP Human Rating Certification Package (HRCP) Checkpoints that meet the intent of NPR 8705.2B and incremental certification reviews, including key products and processes required by the ISS *Visiting Vehicle ISS Integration Plan* (SSP 50964).

1.2 Scope

This Plan is applicable to all NASA organizations contributing to the joint recommendation of CTS Certification by the CCP and ISS Program Managers. Each contributing organization will attest that the necessary tasks, activities, and data products associated with their certification statements have been accomplished. ISS Program activities will be conducted using SSP 50964 which is standard for all ISS visiting vehicles.

The *CTS Certification of Flight Readiness (CoFR) Plan* (CCT-PLN-2100) covers the mission flight readiness plans and processes as well as the interfaces with the *ISS Program Certification of Flight Readiness (CoFR) Process* (SSP 50108) that are required for missions that will enter the ISS approach ellipsoid.

1.3 Delegation of Authority

This document was jointly prepared by and will be jointly managed by the CCP and the ISS Program. The Joint Program Requirements Control Board (JPRCB) is the authority for baselining and approving changes to this document per the Memorandum of Agreement "*ISS Program/CCP MOA, 2013-09-06*." CCT-PLN-2000 will be maintained in accordance with standards for CCP documentation.

2.0 Applicable Documents

2.1 Applicable Documents

Document Number	*Title*: Description
CCT-PLN-1000	*Program Plan Commercial Crew Program*
CCT-PLN-2100	*CCP Certification of Flight Readiness (CoFR) Plan*
CCT-P-4001	*PCB Charter and Process*
HEOMD-CSD-10001	*Commercial Crew Transportation System Certification Requirements for NASA Low Earth Orbit Missions*
Memorandum of Agreement	*ISS Program/CCP MOA, 2013-09-06*
Memorandum of Agreement	*Launch Services Program / CCT-MOA-LSP-1*

2.2 Reference Documents

Document Number	*Title*: Description
CCT-DRM-1110	*Crew Transportation System Design Reference Missions*
CCT-P-3040	*CCtCap DRD Review Process*
CCT-P-3201	*CCtCap Milestone Review Process*
CCT-PLN-1100	*Crew Transportation Plan*
CCT-PLN-1120	*Crew Transportation Technical Management Processes*
CCT-PLN-2200	*Risk Management Plan*
CCT-PLN-3000	*CCP Surveillance Plan*
CCT-REQ-1130	*ISS Crew Transportation and Services Requirements*
CCT-STD-1140	*Crew Transportation Technical Standards and Design Evaluation Criteria*
CCT-STD-1150	*Crew Transportation Operations Standards*
CCT-PLN-3000	*CCP Surveillance Plan*
CCT-WI-3050	*CCP Variance Process Work Instruction*
CCT-WP-2001	*Commercial Crew Certification: Establishing the Framework to Grant Commercial Provider Certification for Transport of NASA Crews to and from the ISS*
SSP 30599	*ISS Safety Review Process*
SSP 50108	*ISS Program Certification of Flight Readiness Process Document*
SSP 50808	*ISS to Commercial Orbital Transportation Services (COTS) Interface Requirements Document (IRD)*
SSP 50964	*Visiting Vehicle ISS Integration Plan*

3.0 CTS Certification

CTS Certification is the integrated certification of four elements: programmatic, design, production, and operations (reference Appendix C for a description on the non-programmatic [aka Commercial Provider] elements) under a shared accountability model between NASA and the Commercial Provider. The Commercial Provider is responsible for the design, development, test, and evaluation (DDT&E) which supports their assertion of meeting the CTS requirements and NASA is responsible for approving the compliance evidence to NASA's requirements.

Figure 3.0: Mission Success

Under this shared accountability model, NASA CCP is accountable for assuring:

- Compliance to the ISS CTS requirements for the ISS Design Reference Mission (DRM) as documented in CCT-REQ-1130
- Compliance with the technical management processes requirements covered in CCT-PLN-1120
- Adherence to the technical standards in CCT-STD-1140 and the operational standards in CCT-STD-1150

NASA ISS Program is accountable for assuring:

- Compliance to the integrated technical requirements in CCT-REQ-1130 [i] requirements
- Compliance to the technical requirements in SSP 50808

Both the CCP and ISS Program will accomplish this through evaluation and approval of the Commercial Provider's compliance evidence and/or variances. After approval of the Commercial Provider's compliance evidence and any additional work associated with each of the CCP Office Certification Statements (reference Appendix F) and applicable ISS Certification endorsements per SSP 50108, NASA CCP, jointly with the ISS Program and Technical Authority / Flight Operations Directorate management, will sign the CTS Certification statements (reference Appendix E) and present a joint Certification recommendation to the Agency. Upon Agency approval of the CTS Certification, the Agency Certification statements (reference Appendix D) will be signed and documented. Should the CTS fail to meet the requirements levied by the CCP and the ISS Program, NASA CTS Certification will not be granted.

3.1 Certification Process Overview

The CCP is executing a phased approach to certify the commercially-developed CTS(s). Figure 3.1 provides the notional CCP milestone path to certification. Flight test missions that are a part of the Commercial Provider's certification plan are not depicted on this figure, but described in detail in CCT-PLN-2100.

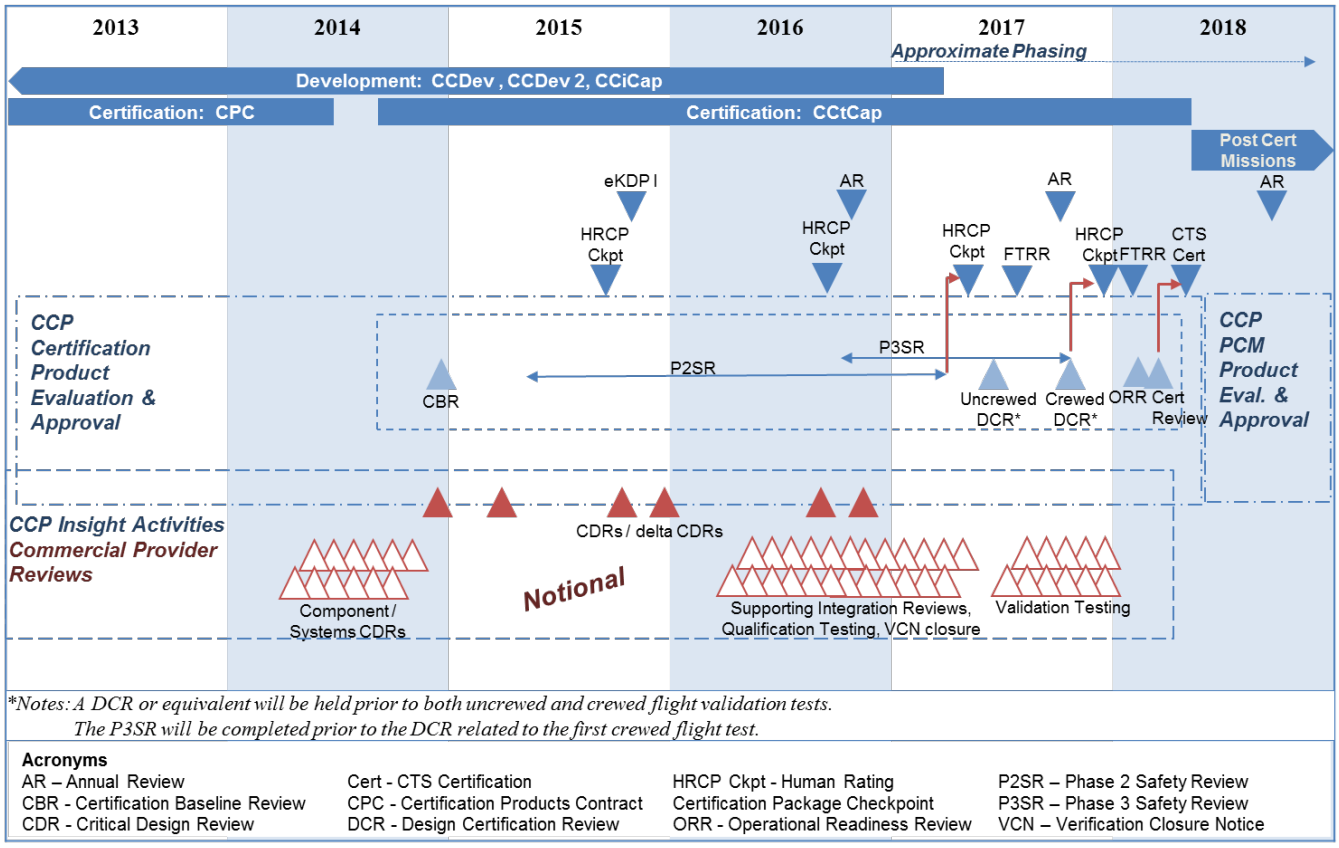


Figure 3-1: Path to CTS Certification

In Phase 1, the CCP used the Certification Products Contract (CPC) for the delivery, technical interchange, and NASA disposition of early life-cycle certification products including variances that are specifically related to an integrated CTS for the ISS DRM. The interaction on these products provided support for the early phase of NASA certification of the Commercial Provider's CTS. CPC was intended to enable NASA and the Commercial Provider to meet these early certification objectives before the Commercial Provider completes its integrated CTS design. The Commercial Provider was required to provide initial and final deliveries of the Commercial Provider alternate standards, Certification Plan, catastrophic Hazard Reports, and Verification and Validation (V&V) Plan and could have requested variances to the NASA requirements. Additionally, the Commercial Provider engaged with the ISS Program to conduct early phase integration in preparation for Phase 2 (see SSP 50964 for more details).

In Phase 2, NASA is using the Commercial Crew Transportation Capability (CCtCap) contract to evaluate the Commercial Provider's end-to-end CTS and to develop the justification/rationale to

substantiate the Commercial Provider's request for NASA CTS Certification. The end-to-end CTS includes all assets and processes required to transport NASA Crew to and from the ISS, including:

- an integrated space vehicle;
- supporting systems for production, ground, flight, and recovery operations;
- capabilities and processes for pre-flight planning and trajectory and abort analysis;
- crew health and medical care;
- capabilities and processes for manufacturing, ground processing, mission control, launch control, and post-landing recovery;
- safety and mission assurance; and
- training processes for operations personnel and crew.

The evaluation will occur through formal contract milestones (reference Section 4) and support to Commercial Provider activities and design reviews (notional reviews are depicted in Figure 3.1). The series of reviews culminate in the Program Certification Review (CR), where the CCP and ISS Program establish a recommendation of the CTS Certification for the Agency's consideration. The content under assessment at the certification reviews includes the design of the end-to-end CTS as well as the production and operation capabilities for steady state operations. Additionally, CCP will host periodic Checkpoints on the Commercial Crew Transportation System (CCTS) HRCP Status with the Agency. At these Checkpoints, the CCP will provide evidence that the Program and its Commercial Providers are complying with the CCTS Human Rating Certification requirements as described in *Commercial Crew Transportation System Certification Requirements for NASA Low Earth Orbit Missions* (HEOMD-CSD-10001) by providing a status summary with linked documentation that supports compliance to all applicable requirements (reference Section 4.1). Prior to the first crewed flight, the CCP will seek interim approval of the Human Rating Certification from the Agency.

3.2 Certification Approach

3.2.1 Shared Assurance Approach

CTS Certification is not fundamentally different than any other NASA spaceflight program, as it consists of a combination of oversight and insight activities, as shown in Figure 3-2.1.

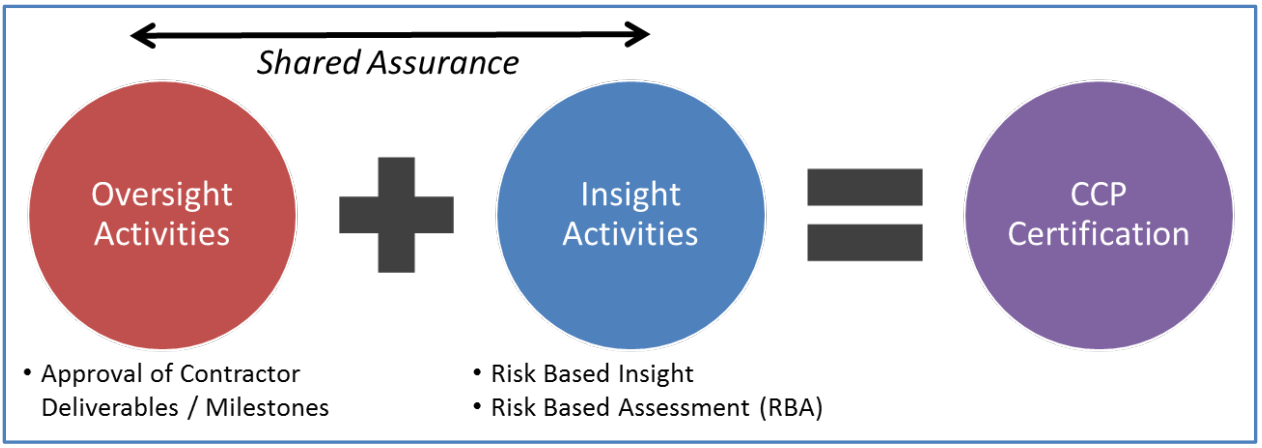


Figure 3-2.1: Certification Model of CCP

To support the Commercial Crew Certification Model, it is critically important for NASA to smartly engage in both oversight and insight activities related to certification to minimize overlap of responsibility by utilizing the most knowledgeable skills throughout the Agency. This Shared Assurance approach is pictorialized in Figure 3-2.3.

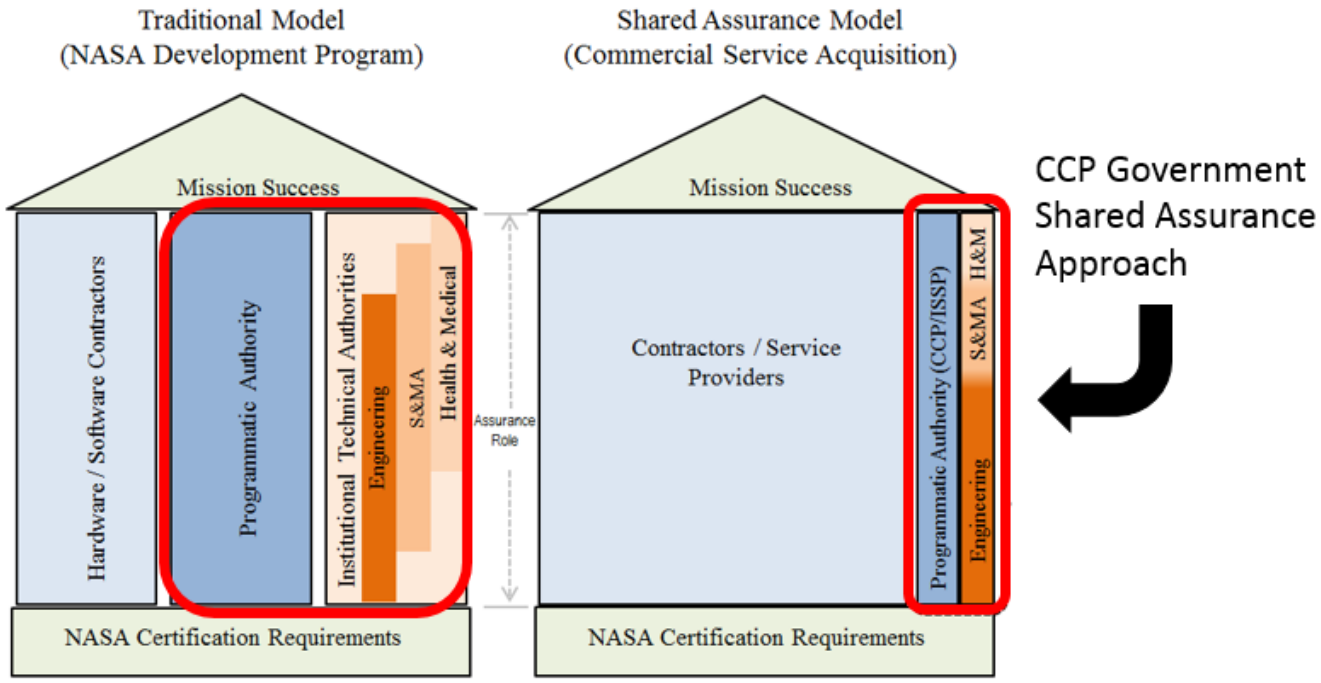


Figure 3-2.3: Shared Assurance Approach

3.2.2 Certification Oversight Approach

NASA implements the shared assurance model through the use of an office of primary responsibility (OPR) and stakeholders for all programmatic oversight activities. Oversight activities are defined as items over which NASA has the final approval authority and have been pre-declared through the CCtCap contract. These include review and approval of each Commercial Provider's:

- Management and Technical Plans
- Certification Plan
- V&V Plan
- Flight Test Plan
- Hazard Reports
- Verification Closure Notices (VCNs)
- Certification Data Package

Details of the required content for each of the Commercial Provider products are contained within the specific CCtCap contract. In addition to the products, NASA oversight includes approval of both the Commercial Provider's interim milestones and certification reviews. The details of all milestones are contained within the specific CCtCap contract, and a summary of key certification reviews is provided in Section 4.0.

VCNs are a prime example of how this oversight process works. All requirements have been assigned an OPR. Within each OPR, every requirement is then assigned to an individual designated as the requirement owner. Clear roles and responsibilities have also been established within the ISS Program for ISS Integration that include the designation of a Visiting Vehicle Integration Manager and various requirement owners within the ISS Program for each SSP 50808 requirement and ISS requirements in CCT-REQ-1130 [i] requirements.

Further, for all requirements, stakeholders have been designated from the CCP Offices, Technical Authorities, and matrixed Support Organizations. Stakeholders will participate in the review of intermediate products and requirement closures. Stakeholders may be matrixed support assigned to provide additional technical expertise, reviews, and risk assessments that will assist the CCP in generating and updating NASA assessments, closure reports, and closing the requirement once verifications are satisfied.

The requirement owner within the OPR and/or the ISS Program is responsible for managing all aspects of the requirement including closure of the verification for the requirement. This will be accomplished by presenting recommendations and rationale, along with any residual risk to the applicable ISS Program and/or CCP boards. The closure recommendation will be based on a culmination of insight gathered throughout Certification and may include reference to a NASA closure report as well as the Commercial Provider VCN. Note that the CCP and the ISS Program have established a Memorandum of Agreement (MOA), "*ISS Program/CCP MOA, 2013-09-06*" which includes details on the partnership managing the development of commercial systems for the ISS DRM.

A similar process to what was described for VCNs has been established for all other oversight activities.

3.2.3 Certification Insight Approach

3.2.3.1 Risk-Based Insight Philosophy and Approach

The CCP Offices are responsible for ensuring that the NASA insight engagement in the Commercial Provider reviews is balanced and commensurate with the assessed Commercial Provider risk. NASA engages in Commercial Provider activities to gain insight into the Commercial Provider's architecture and design definition underlying the verification activities and to understand the boundaries and limitations of the system and its certification. NASA engagement enables the Commercial Provider and NASA to reach a common basis of knowledge about the system and the background data from the verification closure activities.

The CCP Offices, with ISS Program participation, use the following guidelines to continuously assess the Commercial Provider management, design, productions, and operations factors for each of the individual functional disciplines of the CTS. On a case by case basis, the CCP Offices may identify other factors which may be considered before determining the NASA level of engagement.

Commercial Provider Management Risk Factors:

1. Is the Commercial Provider staff highly experienced in developing, operating, and maintaining the subject functional discipline of a crewed spaceflight system?
2. Does the Commercial Provider employ a robust peer review process?

3. Does the Commercial Provider employ a robust independent review process as evidenced by established meetings, outside expert participation, and cross discipline evaluations, which ensures checks and balances?
4. Does the Commercial Provider's organizational structure provide healthy tension between organizational elements?
5. Are the Commercial Provider's standards, technical management processes, and operations mature, strong, and controlled?

Unique Design, Production, and Operation Factors:

1. Is the system a low contributor to the total risk or is it a critical system that is a high contributor?
2. Is the design of the system mature and demonstrated reliable in the relevant environments or is it assessed as a low technology readiness level, first time use, or no experience with the design or operation?
3. Is the complexity of the system design and interfaces simple and well understood or are they complex or have high uncertainties?
4. Are the hazards associated with the system design low or high in terms of likelihood and consequence?
5. Are the system design margins high with low uncertainties, low with high uncertainties, or high with high uncertainties?
6. Has the design demonstrated high reliability with no prior failures or adverse trends or has the design exhibited unexpected failures in previous uses or in development?

This is not a static ranking of the system design risk but will be the starting point for setting the level of engagement by the CCP, as shown in Figure 3-2.4.

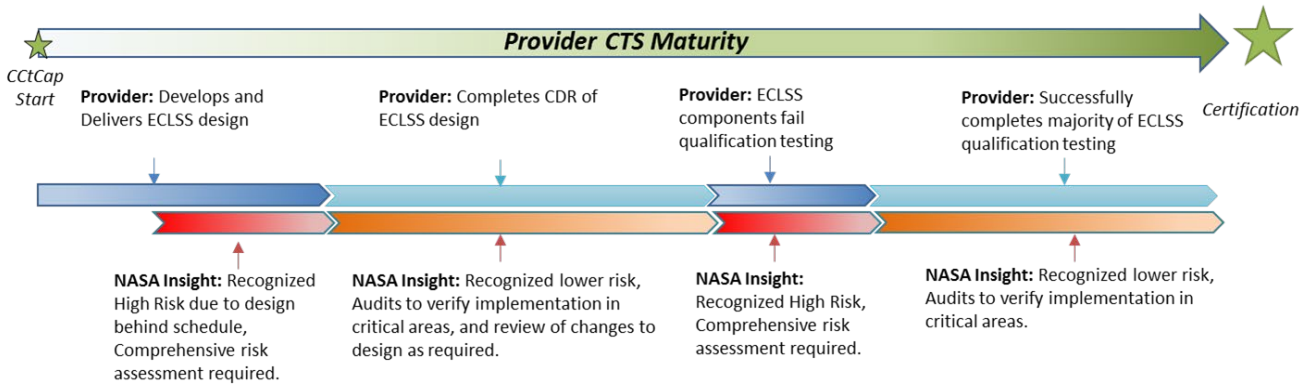


Figure 3-2.4: Notional Risk Based Insight Approach

Changes in any of the engagement factors over time may increase or reduce the need to engage with the Commercial Provider and will be managed by the responsible CCP Offices. Using these guidelines for Commercial Provider and unique design risk factors the CCP Offices can make a technical judgment as to the level of risk associated with the functional discipline.

3.2.4 Levels of Engagement

There are three approaches for NASA engagement in the Commercial Provider's certification activities:

1. Engage in insight activities with the Commercial Provider in preparation for reviewing and approving deliverables through oversight.
2. Conduct joint analysis with the Commercial Provider where NASA has unique analysis capabilities in addition to insight and oversight activities.
3. Perform independent verification and validation in addition to insight and oversight activities. These analyses and assessments require more detailed data from the Commercial Provider to support independent modeling and simulation efforts. Typically, this also drives more technical collaboration with the Commercial Provider.

These approaches represent increasing levels of NASA effort and integration with the Commercial Provider. Requirements evaluated as lower risk will be addressed using the first approach. Approaches 2 and 3 will be applied in higher risk areas.

3.2.4.1 Insight

NASA will use a proactive approach to assess critical elements of the DDT&E and operational phases by maintaining insight into the Commercial Provider's day-to-day activities. NASA is involved in informal data exchange throughout the life-cycle in order to enable NASA's timely recognition of issues involving safety features and reliability concerns that warrant changes while minimizing costly modifications later in the process.

The insight assessment will be a continuous activity and will be adjusted, as necessary, to fit the observations of the CCP Offices and ISS Program. As technical issues and challenges arise, adjustments will be accomplished through collaboration between the appropriate program, technical authority, crew, and operations representatives.

In addition to the continuous insight assessment, insight strategies are developed by the OPR of an oversight activity to guide NASA insight personnel in insight engagement to support eventual certification approval. For Hazard Reports, as an example, the CCP will use a documented risk based analysis (RBA) to determine the appropriate places to provide Government surveillance to support required safety critical attribute verification and validation, as documented in the *CCP Surveillance Plan* (CCT-PLN-3000). The outcome of the RBA is a discreet set of Product Assurance Actions (PAAs) that are executed as part of NASA's insight to assure that the selected hazard control verifications have been performed. For VCNs, as another example, NASA has developed insight strategies to determine which testing, analysis, and/or demonstration activities NASA requires insight into for the ability to later sign off on the actual VCNs. These strategies are maintained by the OPR, will continue to change and mature over-time, and are dependent on the Commercial Provider management and unique factors previously described in Section 3.2.3.1.

3.2.4.2 Independent Verification and Validation (IV&V), Joint Analysis, and Other NASA Technical Assessments

Technical assessment and IV&V tasks performed by NASA will be planned and focused using known areas of high risk and the verification logic networks in the NASA database and in each Commercial Provider's V&V Plan. Each CCtCap contract has defined an initial set of IV&V focus areas, along with the supporting data required by the Commercial Provider for NASA to conduct IV&V. Specific joint analyses required by the ISS Program are defined in the Commercial Provider specific ISS Visiting Vehicle Joint Integration, Verification, and Test Plan.

3.3 Certification of Requirements Allocated to NASA

Not all standards required for certification per HEOMD-CSD-10001 are allocated in full to the Commercial Providers; rather, there are several standards that require verification evidence to be provided by NASA to show compliance certain sections of these standards. The verification evidence for these standards will be documented by the appropriate CCP Office under the applicable Certification themes and statements defined in Appendix E, as shown in Table 3.3.x.

Standard #	Title	Appendix E Statement
NASA-STD-8719.17	*NASA Requirements for Ground-Based Pressure Vessels and Pressurized Systems*	a.1
NPD 8730.1	*Metrology and Calibration*	a.1
NASA-STD-8719.12	*Safety Standard for Explosives, Propellants, and Pyrotechnics*	a.1
NPD 8730.2	*NASA Parts Policy*	a.1
AE/AS5553	*Counterfeit Electronic Parts: Avoidance, Detection, Mitigation and Disposition*	a.1
NASA-STD-3001	*NASA Space Flight Human System Standard*	d.1

Table 3.3.x – NASA Standard Verification mapping to Certification Statements

Reference HEOMD-CSD-10001 for the appropriate applicable sections of NASA-STD-8719.17, NPD 8730.1, NASA-STD-8719.12, NPD 8730.2 and AE/AS5553. The appropriate sections of NASA-STD-3001 that require NASA verification evidence are dependent on the Government Provided Services being provided for a specific Commercial Provider.

3.4 Certification Maintenance

Certification maintenance is the responsibility of the Commercial Provider into which NASA has oversight/approval. As such, the Commercial Provider will bring to the CCP and ISS Program, as part of its operating plans, changes to the certification baseline with rationale for the acceptability. When any change or set of changes are deemed to affect the baseline established at CTS Certification, NASA will assess the need for a new CTS Certification or, in cases of unacceptable risk, nullify the Commercial Provider's NASA CTS Certification.

4.0 Certification Reviews and Checkpoints

The CCP purpose, review requirements, and review board membership for each incremental certification review are defined below, and include the Design Certification Reviews (DCRs), Operational Readiness Review (ORR), and the Program and Agency CRs. Each of these reviews is either chaired or co-chaired by NASA with mandatory attendance by the CCP's Program Control Board (PCB) membership in the *Commercial Crew Program Control Board Charter and Process*, Section VI (CCT-P-4001).

At the conclusion of the uncrewed DCR, crewed DCR, ORR, and CR, a poll of all Board members shall be conducted. When polled, the members are expected to state their recommendation from their perspective as a senior manager of their area of responsibility. Members are also expected to provide comments and recommendations on issues raised during the reviews. Members should use their subject matter experts and operational experience to ensure that a thorough exploration of relevant facts has been completed and that the meeting process has produced a logical conclusion. The Review Chair shall consider the poll results when formulating the final decision. The readiness poll shall be performed per a checklist, which shall become part of the formal records of the CR.

Per NPD 1000.0A, NASA Governance and Strategic Management Handbook, in assessing a decision or action, a member has three choices: agree, disagree but be willing to fully support the decision, or disagree and raise a formal dissent. Formal dissents shall be addressed using the process set forth in CCT-P-4001, and a reclama may proceed all the way to the NASA Administrator, as required. Formal dissents will also be documented in accordance with the *Program Plan Commercial Crew Program* (CCT-PLN-1000) Appendix C, 7120.5E Compliance Matrix.

It is the responsibility of every board member to ensure the entire Review Board is aware of formal dissents, that the formal dissents are discussed, and that the dissenter is advised of the disposition. The Review Chair will elevate, to the Center or HEO management as appropriate, all decisions that have a formal dissent. The Review Chair and the representative of the dissenter's organization will jointly present the agreed upon facts and the respective positions, rationale, and recommendations. If the dissenter is not satisfied with the process or outcome, the dissenter may appeal to the next higher level of management. The dissenter has the right to take the issue upward through the organization, even to the NASA Administrator, if necessary.

4.1 CCTS Human Rating Certification Checkpoints

The CCP will periodically provide to Agency stakeholders a status of the pertinent plans and documents generated by both NASA and Industry relative to meeting the technical human rating requirements per HEOMD-CSD-10001. The Checkpoint package will:

- Provide evidence that the CCP and its Commercial Providers are following the CCTS Human Rating Certification requirements as defined in HEOMD-CSD-10001 by providing documentation that supports compliance to all applicable requirements.
- Identify watch areas and open items where products, processes, or designs need to be further matured.
- Provide opportunity for broad review and comment on CCTS Human Rating Certification status of acceptable human rating progress.

Prior to the first crewed flight, the CCP will seek interim approval of the Human Rating Certification from the Agency.

4.2 Design Certification Review

The CCP with ISS Program representation will jointly conduct an uncrewed and crewed DCR with the Commercial Provider prior to both the uncrewed and crewed flight tests. The DCRs will be held in accordance with the contract defined entrance/exit criteria; NASA approved Commercial Provider's Milestone Review Plan, which lays out the review logistics and products to meet the contract entrance/exit criteria; and baselined review schedules. The purpose of the DCRs are to:

- Demonstrate that the CTS and operations meet all applicable requirements, as defined in CCT-REQ-1130 and SSP 50808 in order to meet the ISS DRM.
- Provide evidence that the Commercial Provider's CTS has met all applicable requirements through the implementation of its baselined management and certification plans and processes required in CCT-PLN-1120.
- Define the Commercial Provider's top safety, technical, cost, and schedule risks.

The decision at the DCRs establishes the certification baseline which will be used and referenced in subsequent flight and operational readiness reviews. The DCRs will establish the conditions/constraints under which the system is certified for a specific Flight Test or for final CTS Certification, identify the accepted risks, and ensure that any required ISS integration is complete or planned for completion per nominal ISS integration template. Successful completion of DCR is prerequisite for each flight test to the ISS.

4.2.1 DCR Requirements

The DCR agenda will include presentations from the Commercial Provider and NASA addressing, at a minimum, the following:

1. The Commercial Provider shall present a summary of the DCR Data Package including:
    a. summary of the Certification Data Package,
    b. integrated vehicle performance, margin, and constraints,
    c. variances,
    d. identification of open items with the plan for completion, and
    e. assessments of top safety, technical, cost, and schedule risks.
2. CCP shall present:
    a. an integrated summary of NASA's review with an emphasis on resolution of major programmatic and technical issues, areas where risk has been accepted by NASA, and areas where significant open issues remain,
    b. summary of the Human Rating Certification Data Package contents,
    c. status of any CCP Government provided services,
    d. status summary of previous review action items, and
    e. Certification status.
3. ISS shall present:
    a. status of open actions from ISS reviews,
    b. status of ISS analysis and operational products,
    c. status of any ISS Government furnished equipment or services, and
    d. Certification status.
4. Chair will conduct a poll requesting discussion on any formal dissents.

4.2.2 DCR Board Membership

Program DCR Board
Chair Manager, Commercial Crew Program Manager, Commercial Provider
Secretariat Manager, Program Control and Integration Office, Commercial Crew Program
Members Commercial Crew Program Control Board Membership ISS Program Management and ISS organizational support Commercial Provider Board Membership

4.3 Operations Readiness Review

The CCP with ISS Program representation will hold an Operations Readiness Review (ORR) with the Commercial Provider. The ORR will be held in accordance with the contract defined entrance/exit criteria, NASA approved Commercial Provider's Milestone Review Plan, which lays out the review logistics and products to meet the contract entrance/exit criteria, and baselined review schedules. The purpose of the ORR is to demonstrate that the actual CTS system characteristics and the procedures used in operations reflect the deployed state of the CTS. The ORR evaluates all project and support (flight and ground) hardware, software, personnel, and procedures to ensure flight and associated ground systems are in compliance with Program requirements and constraints.

A prerequisite to ORR is the successful completion of the crewed flight test to the ISS. The decision at the ORR will establish the NASA acceptance of CTS readiness in support of the CTS Certification.

4.3.1 ORR Requirements

The ORR Agenda will include presentations from the Commercial Provider and NASA addressing, at a minimum, the following:

1. The Commercial Provider shall present a summary of the ORR Data Package; demonstrating flight and ground system compliance and a readiness to be placed in a steady state operations status, including:
    a. summary of changes to the Certification Data Package since DCR,
    b. summary of operational capabilities for nominal and contingency operations and the readiness for sustaining operations,
    c. summary of plans, procedures, and training for nominal and contingency operations,
    d. identification of open items with the plan for completion, and
    e. assessments of top safety, technical, cost, and schedule risks.
2. NASA shall present:
    a. an integrated summary of NASA's review of the CTS Operations systems: emphasis shall be placed on resolution of major programmatic and technical issues, areas where risk has been accepted by NASA, and areas where significant open issues remain,
    b. status of any Government furnished equipment or services,
    c. status summary of previous review action items, and
    d. Certification status.
3. Chair will conduct a poll requesting discussion on any formal dissents.

4.3.2 ORR Board Membership

ORR Board
Chair Manager, Commercial Crew Program Manager, Commercial Provider
Secretariat Manager, Program Control and Integration Office, Commercial Crew Program
Members Manager, ISS Program and ISS organizational support Commercial Crew Program Control Board Membership Commercial Provider Board Membership

4.4 Program Certification Review

The CCP with ISS Program representation will hold a Program CR with the Commercial Provider. The Program CR will be held in accordance with the contract defined entrance/exit criteria; NASA approved Commercial Provider's Milestone Review Plan, which lays out the review logistics and products to meet the contract entrance/exit criteria; and baselined review schedules. The purpose of the Program CR is to demonstrate that the CTS has met all NASA CTS requirements and to address any residual risk to crew safety and mission assurance. Prior to this review, each CCP Office shall complete all necessary supporting tasks to sign the Certification statements in Appendix F. Additionally, the ISS Program shall complete all necessary supporting tasks to sign the applicable Certification endorsements identified in SSP 50108. The outcome of this review is the Program's formal recommendation of CTS Certification, as denoted by the formal signature of the Certification statements in Appendix E.

Completion of a successful ORR is a prerequisite to holding a Program CR.

4.4.1 Program CR Requirements

The Program CR agenda will include presentations from the Commercial Provider and CCP SE&I addressing, at a minimum, the following:

1. The Commercial Provider shall present a summary of the CR Data Package including:
    a. summary of the Certification Data Package,
    b. integrated vehicle performance, margin, and constraints,
    c. variances,
    d. summary of operational roles, responsibilities, and procedures,
    e. identification of open items with the plan for completion, and
    f. assessments of top safety, technical, cost, and schedule risks.
2. CCP shall present
    a. an integrated summary of NASA's review of the CTS Design: emphasis shall be placed on resolution of major programmatic and technical issues, areas where risk has been accepted by NASA, and areas where significant open issues remain,
    b. summary of the Human Rating Certification Data Package contents
    c. status summary of previous review action items, and
    d. Certification Approval, including certification of any CCP Government provided services.

3. ISS shall present Certification Approval, including certification of any ISS Government furnished equipment or services.
4. Chair will conduct a poll requesting discussion on any formal dissents.

4.4.2 Program CR Board Membership

Program CR Board
Chair Manager, Commercial Crew Program Manager, ISS Program
Secretariat Manager, Program Control and Integration Office, Commercial Crew Program
Members Commercial Crew Program Control Board Membership Manager, Commercial Provider ISS Program Representatives, as required Commercial Provider Board Membership

4.5 Agency Certification Review

The Agency will conduct an Agency CR to evaluate the design, production, and operations of the CTS. The purpose of the Agency CR is to demonstrate that the CTS has met all applicable NASA Crew Transportation System requirements and request that the Commercial Provider's CTS be certified for the full DRM to transport NASA Crew to the ISS based on evidence of satisfactorily completing the CTS Certification activities, except as noted in approved variances. Prior to conducting the Agency CR, completion of the Program CR is required. Upon successful completion of the Agency CR, NASA will grant CTS Certification, as denoted by the signature to the formal signature of the Certification statements in Appendix E.

Completion of a successful Program CR is a prerequisite to holding the Agency CR.

4.5.1 Agency CR Requirements

The Agency CR agenda will include presentations from NASA and the Commercial Provider addressing, at a minimum, the following:

1. The Commercial Provider shall present a summary of the CR Data Package including:
    a. summary of the Certification Data Package,
    b. integrated vehicle performance, margin, and constraints,
    c. variances,
    d. summary of operational roles, responsibilities, and procedures,
    e. identification of open items with the plan for completion, and
    f. assessments of top safety, technical, cost, and schedule risks.
2. CCP shall present:
    a. an integrated summary of NASA's review of the CTS Design: emphasis shall be placed on resolution of major programmatic and technical issues, areas where risk has been accepted by NASA, and areas where significant open issues remain,
    b. summary of the Human Rating Certification Data Package contents,
    c. status summary of previous review action items, and

d. Certification Approval, including certification of any CCP Government provided equipment or services.

3. ISS shall present Certification Approval, including certification of any ISS Government provided equipment or services.
4. Chair will conduct a poll requesting discussion on any formal dissents.

4.5.2 Agency CR Board Membership

Agency CR Board
Chair Associate Administrator, Space Operations Mission Directorate, NASA
Secretariat Manager, Program Control and Integration Office, Commercial Crew Program, NASA
Members Manager, Commercial Crew Program, NASA Manager, ISS Program, NASA Manager, Commercial Provider Chief Engineer, NASA Chief Health and Medical Officer, NASA Chief Safety and Mission Assurance Officer, NASA Director for Commercial Spaceflight Development, NASA Director, Kennedy Space Center, NASA Director, Johnson Space Center, NASA Director, Marshall Space Flight Center, NASA

5.0 Roles and Responsibilities for Certification

This section describes the Certification roles and responsibilities for CCP management and organizations, TAs, and applicable NASA Directorates and their associated contractors.

5.1 NASA CCP Manager

The NASA CCP Manager is responsible for establishing the Program Certification process; ensuring the successful completion of Program requirements, tasks, and activities; and providing Program approval of CTS Certification. The NASA CCP Manager controls the CCP Certification process through the Program Control Board, co-chairs the DCR, ORR, and Program CR, and represents the CCP at the Agency CR.

5.2 CCP Offices

All CCP Offices lead both oversight activities and insight engagement within their area of responsibility, including tasking stakeholders and other Support Organizations as necessary. Each office is responsible for ensuring that all tasks required for Certification are complete and in accordance with the Shared Assurance model of CCP. This means, where appropriate, the CCP Office may not be doing the work specifically, but will rely upon other offices and stakeholders to perform the actual tasks to support Certification. Ultimately, the CCP Office must attest to the completion of the task whether it was performed by their office or not. To facilitate this process, each System Office will develop, disseminate, and mature insight strategies related to their oversight activities.

At the Program CR, the NASA CCP office managers shall, through the submittal of Office Certification Statements, certify the completion of all tasks and activities for which they are responsible.

5.3 CCP Systems Engineering and Integration Office

The CCP SE&I Office is responsible for leading and coordinating both the technical and process integration to support the Program's CTS Certification and CRs. The CCP SE&I Office will integrate, coordinate, and track the evaluation of the design, production, manufacturing, and operations processes that are required to support the CTS Certification recommendation, specifically focusing on VCNs, Hazard Reports, and variances to NASA's requirements. SE&I will also ensure that insight strategies related to oversight activity approvals, as discussed in Section 3.2.4.1 are generated, disseminated and matured throughout Certification.

In preparation for the DCRs, ORRs, and CRs, the SE&I Office will facilitate coordination meeting(s) as required with representatives from all the CCP Offices, TAs, and Support Organizations, to ensure that any exceptions/impacts to CTS Certification statements are scheduled for the presentation.

5.4 Technical Authorities and Stakeholders

The Engineering, Safety and Mission Assurance, and Health and Medical Technical Authorities (TAs) and Flight Operations Directorate (FOD) are stakeholders of many of the CTS requirements. Their roles and responsibilities related to Certification as stated in CCT-PLN-1000 are as follows:

- determine the acceptability of the system for certification,
- determine the acceptability of the individual products documented in the Certification Plan, and
- determine the acceptability of requests for variances to the certification requirements.

The TAs and FOD will provide matrixed personnel to the CCP Offices with the required systems or discipline expertise to support all CCP Office Certification activities and reviews. The TAs and FOD are members of the various boards and panels in the existing CCP Board structure through which Certification decisions are processed.

5.5 ISS Program

To support CCP CTS Certification activities, the ISS Program will verify CTS requirements compliance by executing integration and verification processes for first time visiting vehicles as defined in SSP 50964 and SSP 50108. The ISS Program will focus on CTS requirements levied by SSP 50808 and CCT-REQ-1130 [i]. In addition, the ISS Program will confirm compliance with CCT-PLN-1120 process requirements for which it has identified itself as a requirement stakeholder; as well as confirm CTS design, operations, and production can provide steady state missions and services to ISS for the life of the CCtCap contract. The Transportation Integration Office will lead ISS CTS Certification activities for the ISS Program.

5.6 Supporting Organizations

To support CCP CTS Certification activities, the CCP tasks various support organizations to perform Government furnished services, tasks, or activities. These support organizations include but are not limited to:

- Federal Aviation Administration
- NASA Space Communications And Navigation (SCAN)
- NASA Public Affairs Office (PAO)
- USAF 45th Space Wing, Eastern Test Range
- USAF 45th Operations Group Detachment-3
- U.S. Strategic Command (USSTRATCOM)
- KSC Spaceport Integration and Services
- KSC Information and Technology and Communication Services

Each Support Organization is tasked from the CCP via a Systems Office, Program Control and Integration (PC&I), or its contract specified as a Government Furnished Service. At each specified certification review, the tasking CCP office shall certify the completion of tasks and activities for which the Support Organizations are responsible, including the completion of tasks required to support the overall Certification.

The tasking CCP office shall satisfy the applicable Certification themes and statements defined in Appendix E certifying the Support Organization’s capability.

6.0 Certification Statements and Approval

6.1 Certification Statements Overview

CTS Certification encompasses four elements: Programmatic, Design, Production, and Operations. For each Certification element a certification theme and statements have been developed (reference Appendix F and Figure 6.1.1) to both define the scope of the element and enable tracking of Certification Status.

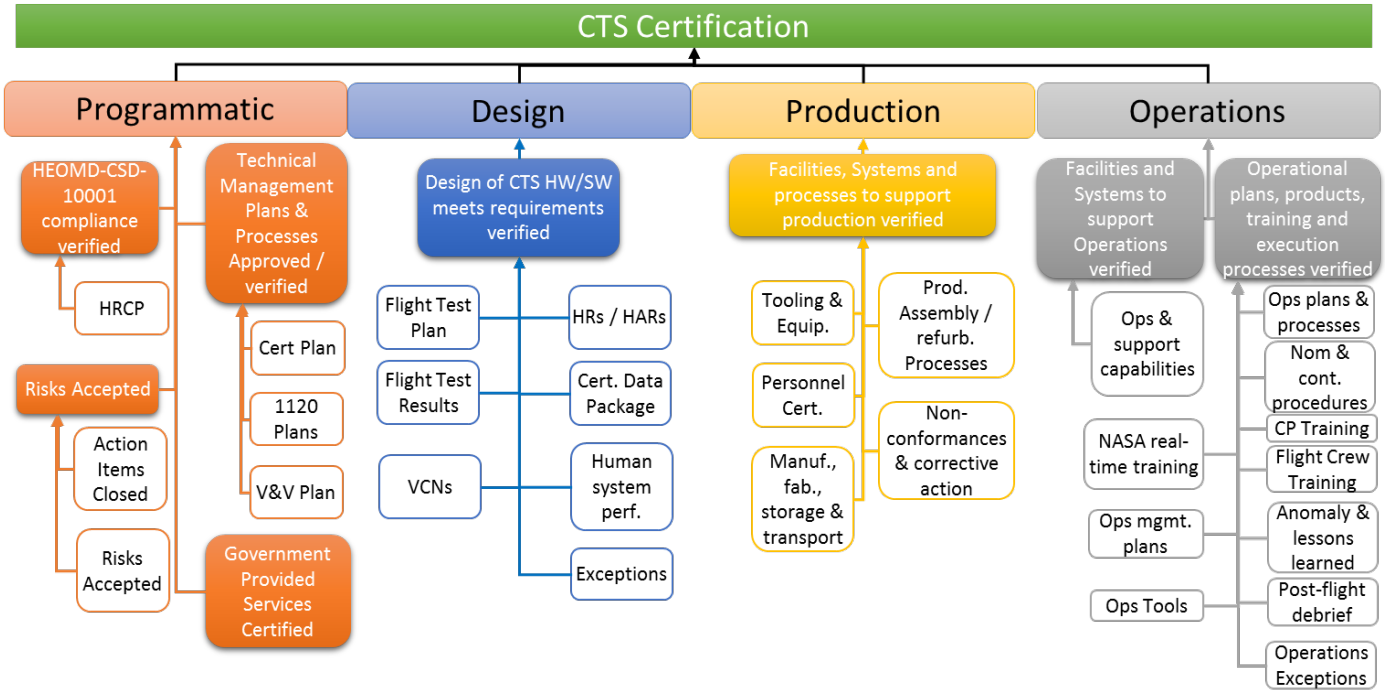


Figure 6.1 – Certification Theme / Statement Overview

Each CCP Office is responsible for ensuring the work necessary to substantiate the Commercial Provider's assertion of meeting certification requirements has been successfully completed, as defined in the Certification statements. Of note, production certification is related to the work for hardware production of the spacecraft and launch vehicle at the production facilities, and operations certification includes the work related to final assembly, integration, test and check out at the launch site, final preparations for landing and recovery, in addition to training development of the launch and mission support personnel. Each CCP Office will sign the applicable Certification statements prior to the CR, certifying that all associated activities for which the Office has responsibility have been satisfactorily completed.

The CCP SE&I Office will coordinate among the organizations sharing responsibilities for a particular theme to ensure no shortfall of coverage and minimize overlaps, and provide a programmatic certification recommendation to the CCP Manager once all certification statements have been completed.

6.1.1 Certification Supporting Evidence

The supporting evidence for Certification will be comprised of approval of Commercial Provider plans and evaluation of the Commercial Provider's data packages. Figure 6.1 is an overview of the types of evidence that could support Certification statements. NASA's efforts for verification and validation of CCT-REQ-1130 and SSP 50808 requirements and certification statements of CCT-PLN-1120 technical management and process requirements are comprised of NASA approved Commercial Provider Certification products including: Alternate Standards and Variances to NASA's certification requirements; Safety and Reliability analysis products and Hazard Analysis Reports; V&V Plan and subsequent VCNs (including joint analyses and tests) and targeted independent assessment efforts; Certification Plan and subsequent Certification Data Package; and technical management plans and processes with subsequent audit/surveillance of compliance to the established processes. These efforts are conducted per the established CCP certification review and approval processes, including key board approvals leading to and contributing to Certification confidence, referenced in Section 4.0.

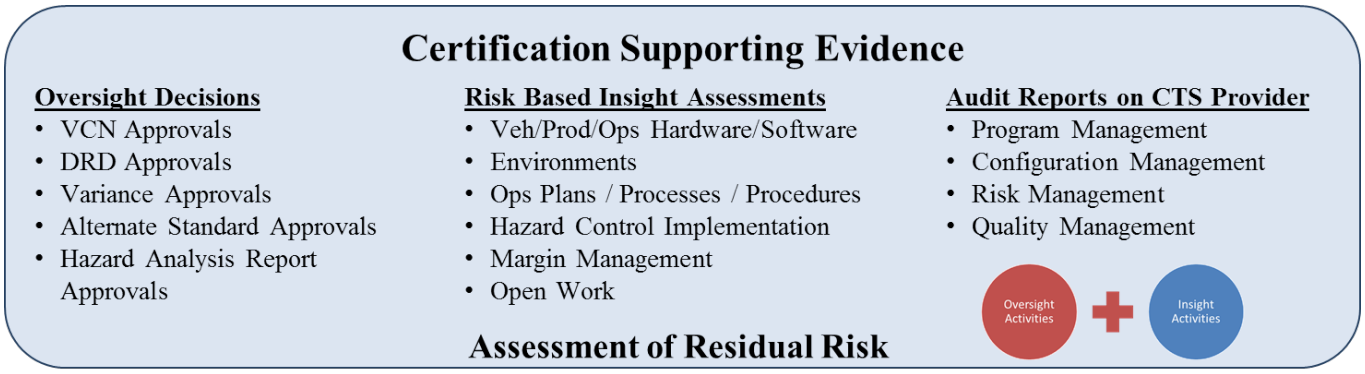


Figure 6.1.1: Certification Supporting Evidence

6.1.2 Certification Supporting Evidence Tracking

The work performed by CCP in support of Certification is tracked in the Certification/CoFR Evidence List/Log (CELL). The CELL is the system office specific implementation plan of both the Certification and CoFR Plans. Each CELL shall be under configuration control, maintained by the CCP Office, and available for review. At a minimum, the contents of the CELL shall:

1. identify the task and the responsible System Office(s),
2. the completion status, and
3. identify data products, tasks, and activities used to arrive at a certification decision, and the location of the data (e.g., CCP SharePoint, CRADLE database, Product Assurance Action database or Commercial Provider database),

The **Master CELL**, maintained by SE&I for Certification and MM&I for CoFR, is Commercial Provider independent, and contains a matrix of all the identified supporting tasks and general evidence of completion, as well as the CCP Office that is accountable for attesting to that task's completion.

The **Office CELL** is Commercial Provider dependent, and contains any additional specifics required by each office to further define their overall Certification / CoFR implementation expectations between their stakeholders and the Commercial Providers. This includes:

- Definition of data products, tasks, and activities used to arrive at a certification decision
- Reconciliation of expectations with the office stakeholders
- Identification of the person(s) accountable for the task to be completed

6.2 Certification Approval

The NASA CTS Certification is granted in the Agency CR but is dependent on the certification compliance from CCP and ISS teams. Figure 6.2, Certification Approval Hierarchy, illustrates the relationship of those certifying organizations to the Program and Agency Certification Approval. The roles of each of the organizations has been defined in Section 5.0.

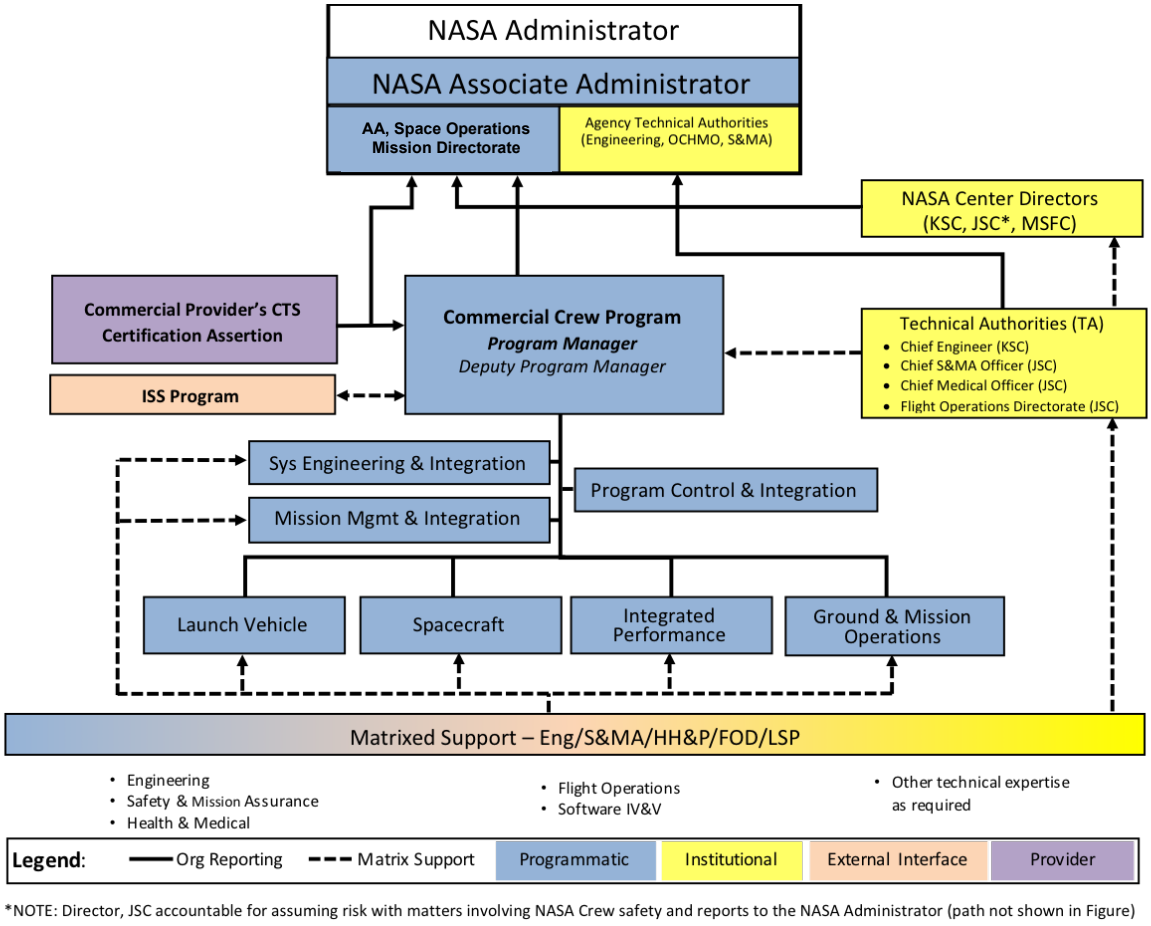


Figure 6.2: Certification Approval Hierarchy

6.3 Certification Review Documentation

The CCP PC&I Office shall maintain the following official documentation of each Program CR and the Agency CR.

1. action item log,
2. applicable Certification certificates – signed,
3. listing of open work with identified constraints,
4. signed Statements of Certification Recommendation for each organization,
5. review briefing materials and supporting documentation,
6. delegation of authority letters,
7. readiness poll checklist – signed,
8. meeting audio recording, and
9. approved review minutes:
    a. Records of the reviews will be detailed enough to review discussions and decision logic.
    b. Formal dissents will also be documented in accordance with CCT-PLN-1000, Appendix C, 7120.5E Compliance Matrix.

Appendix A: Acronyms

Acronyms	Phrase
CCP	Commercial Crew Program
CCT	Commercial Crew Transportation
CDR	Critical Design Review
CCtCap	Commercial Crew Transportation Capability
CELL	Certification / CoFR Evidence List/Log
CHSIP	Commercial Human System Integration Process
CoFR	Certification of Flight Readiness
COTS	Commercial Orbital Transportation System
CPC	Certification Products Contract
CTS	Crew Transportation System
CCTS	Commercial Crew Transportation System
CR	Certification Review
DCR	Design Certification Review
DDT&E	Design, Development, Test, and Evaluation
DRM	Design Reference Mission
ECD	Estimated Completion Dates
e.g.	That is, for example, such as
FOD	Flight Operations Directorate
G&MO	Ground and Mission Operations
GSE	Ground Support Equipment
HEOMD	Human Exploration and Operations Mission Directorate
HRCP	Human Rating Certification Package
IRD	Interface Requirements Document
ISS	International Space Station
IP	Integrated Performance
IV&V	Independent Verification and Validation
JPRCB	Joint Program Requirements Control Board
JSC	Johnson Space Center
KSC	Kennedy Space Center
MM&I	Mission Management and Integration
MOA	Memorandum of Agreement
MRB	Material Review Board
NASA	National Aeronautics and Space Administration
NDE	Non-Destructive Evaluation
OPR	Office of Primary Responsibility
ORR	Operational Readiness Review
PAA	Product Assurance Actions
PAO	Public Affairs Office
PBS	Product Breakdown Structure
PCB	Program Control Board
PC&I	Program Control and Integration

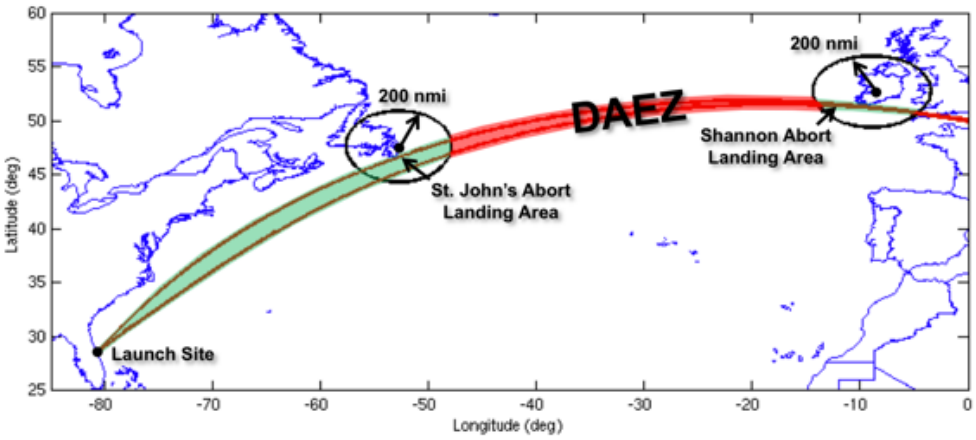
Acronyms	Phrase
RBA	Risked Based Analysis
SCAN	Space Communications And Navigation
SE&I	Systems Engineering and Integration
SOMD	Space Operations Mission Directorate
TA	Technical Authority
USSTRATCOM	U.S. Strategic Command
V&V	Verification and Validation
VCN	Verification Closure Notice

Appendix B: Definitions

Term	Definition
Abort	The forced early return of the crew when failures or the existence of uncontrolled catastrophic hazards prevent continuation of the mission profile and a return is required for crew survival.
Ambient Light	Any surrounding light source (existing lighting conditions). This could be a combination of natural lighting (e.g., sunlight, moonlight) and any artificial light source provided. For example, in an office there would be ambient light sources of both the natural sunlight and the fluorescent lights above (general office lighting).
Analysis	A verification method utilizing techniques and tools, such as math models, prior test data, simulations, analytical assessments, etc. Analysis may be used in lieu of, or in addition to, other methods to ensure compliance to specification requirements. The selected techniques may include, but not be limited to, task analysis, engineering analysis, statistics and qualitative analysis, computer and hardware simulations, and analog modeling. Analysis may be used when it can be determined that rigorous and accurate analysis is possible, test is not cost effective, and verification by inspection is not adequate.
Annunciate	To provide a visual, tactile, or audible indication.
Approach Ellipsoid	A 4 x 2 x 2 km ellipsoid, centered at the ISS center of mass, with the long axis aligned with the V-Bar.
Approach Initiation	The approach initiation is the first rendezvous maneuver during a nominal approach that is targeted to bring the vehicle inside the ISS approach ellipsoid (AE).
Ascent	The period of time from initial motion away from the launch pad until orbit insertion during a nominal flight or ascent abort initiation during an abort.
Ascent Abort	An abort performed during ascent, where the crewed spacecraft is separated from the launch vehicle without the capability to achieve the desired orbit. The crew is safely returned to a landing site in a portion of the spacecraft nominally used for entry and landing/touchdown.
Audit	A documented systematic, independent, official, examination, analysis, verification and validation of: records and other objective evidence of work performed; the requirements; the process or process requirements to determine compliance with requirements; and to assess the effectiveness of implementation and identify potential improvements.
Automated	Automatic (as opposed to human) control of a system or operation.
Autonomous	Ability of a space system to perform operations independent from any ground-based systems. This includes no communication with, or real-time support from, mission control or other ground systems.
Backout	During mission execution, the coordinated cessation of a current activity or procedure and careful return to a known, safe state.

Term	Definition
Breakout	Any action that interrupts the nominally planned free flight operations that are intended to place the spacecraft outside of a threatening location to the cooperative vehicle. This may be an automated or manually executed action. For the ISS, the area within which a vehicle poses a threat to ISS is called the Approach Ellipse.
Cargo	An item (or items) required to maintain the operability of the ISS and/or the health of its crew, and that must be launched and/or returned.
Catastrophic Event	An event resulting in the death or permanent disability of a ground closeout or flight crewmember, or an event resulting in the unplanned loss/destruction of a major element of the CTS or ISS during the mission that could potentially result in the death or permanent disability of a flight crewmember.
Catastrophic Hazard	A condition that could result in the death or permanent disability of a ground closeout or flight crewmember, or in the unplanned loss/destruction of a major element of the CTS during the mission that could potentially result in the death or permanent disability of a flight crewmember.
Certificate of Flight Readiness	A certificate containing a set of signed endorsements (wet ink or electronically) attesting to the readiness of flight systems, ground systems/facilities, software, personnel, flight products, and external Support Organizations to support all mission phases within acceptable levels of risk.
CoFR Endorsement	Statements certifying (attesting to) readiness for continuing towards launch/flight operations which are collected at the appropriate level for the review in which they are signed.
CoFR Exception	Any item, except Standard Open Work and approved variances, required for completion of a CoFR Endorsement that is not complete at the time of the CoFR review.
CoFR Record	Any record retained as evidence of a successful CoFR process for each mission.
Command	Directive to a processor or system to perform a particular action or function.
Communications Coverage	Communication coverage is defined as successful link availability for nominal ascent and entry trajectories.
Communications Link	A communication link is established, whereas the received commands and voice from the CVCC to the spacecraft and the transmitted health and status data, crew health and medical related data, voice, telemetry, and transmitted launch vehicle and spacecraft engineering data are received.
Consumable	Resource that is consumed in the course of conducting a given mission. Examples include propellant, power, habitability items (e.g., gaseous oxygen), and crew supplies.
Continental U.S. Airport	An airport within the continental United States capable of accommodating executive jet aircraft similar to the Gulfstream series aircraft.
Contingency	Provisioning for an event or circumstance that is possible but cannot be predicted with certainty.
Contingency Spacecraft Crew Support (CSCS)	CSCS is declared when the spacecraft crew takes shelter on the ISS because the spacecraft has been determined to be unsafe for reentry. In this case, a rescue mission is required to return the spacecraft crew safely.
Crew	Any human onboard the spacecraft after the hatch is closed for flight or onboard the spacecraft during flight.

Term	Definition
Crew Transportation System (CTS)	The collection of all space-based and ground-based systems (encompassing hardware and software) used to conduct space missions or support activity in space, including, but not limited to, the integrated space vehicle, space-based communication and navigation systems, launch systems, and mission/launch control.
Critical	[1] The condition where failure to comply with prescribed contract requirements can potentially result in loss of life, serious personal injury, loss of mission, or loss of a significant mission resource. Common uses of the term include critical work, critical processes, critical attributes, and critical items. [2] A condition that may cause severe injury or occupational illness, or major property damage to facilities, systems, or flight hardware.
Critical Decision	Those technical decisions related to design, development, manufacturing, ground, or flight operations that may impact human safety or mission success, as measured by defined criteria.
Critical Fault	Any identified fault of software whose effect would result in a catastrophic event or abort.
Critical Function	Mission capabilities or system functions that, if lost, would result in a catastrophic event or an abort.
Critical Hazard	A condition that may cause a severe injury or occupational illness.
Critical Software	Any software component whose behavior or performance could lead to a catastrophic event or abort. This includes the flight software, as well as ground-control software.
Critical Software/ Firmware	Software/Firmware that resides in a safety-critical system that is a potential hazard cause or contributor, supports a hazard control or mitigation, controls safety-critical functions, or detects and reports 1) fault trends that indicate a potential hazard and/or 2) failures which lead to a hazardous condition.
Critical (sub)System	A (sub)system is assessed as critical if loss of overall (sub)system function, or improper performance of a (sub)system function, could result in a catastrophic event or abort.
CTS Certification	CTS certification is the documented authorization granted by the NASA Associate Administrator that allows the use of the CTS within its prescribed parameters for its defined reference missions. CTS certification is obtained prior to the first crewed flight (for flight elements) or operational use (for other systems).
CTS Element	One component part of the overall Crew Transportation System. For example, the spacecraft is an element of the CTS.
Deconditioned	"Deconditioned" defines a space crewmember whose physiological capabilities, including musculoskeletal, cardiopulmonary, and neurovestibular, have deteriorated as a result of exposure to micro-gravity and the space environment. It results in degraded crewmember performance for nominal and off-nominal mission tasks.
Definitive Medical Care	An inpatient medical care facility capable of comprehensive diagnosis and treatment of a crewmember's injuries or illness without outside assistance—capable of care of Category I, II, and III trauma patients. Usually a Level I trauma center, as defined by the American College of Surgeons.

Term	Definition
Demonstration	A method of verification that consists of a qualitative determination of the properties of a test article. This qualitative determination is made through observation, with or without special test equipment or instrumentation, which verifies characteristics, such as human engineering features, services, access features, and transportability. Human-in-the-loop demonstration is performed for complex interfaces or operations that are difficult to verify through modeling analysis, such as physical accommodation for crew ingress and egress. Demonstration requirements are normally implemented within a test plan, operations plan, or test procedure.
Formal dissent	A disagreement with a decision or action that an individual judges is of sufficient importance that it warrants a specific review and decision by higher level management and the individual specifically requests that the dissent be recorded and resolved by the formal dissent process.
Docking	Mating of two independently operating spacecraft or other systems in space using independent control of the two vehicles' flight paths and attitudes during contact and capture. Docking begins at the time of initial contact of the vehicles' docking mechanisms and concludes when full rigidization of the interface is achieved.
Downrange Abort Exclusion Zone	A geographical region of the North Atlantic Ocean to be avoided for water landings during ascent aborts for ISS missions due to rough seas and cold water temperatures. The region is depicted in Figure B-1. The St. John's abort landing area includes the waters within 200 nmi range to St John's International Airport (47° 37' N, 52° 45' W). The Shannon abort landing area includes the waters within 200 nmi range to Shannon International Airport (52° 42' N, 8° 55' W). Note: The northern and southern bounds of the DAEZ in the ISS Mission DAEZ figure are notional, as these bounds are limited only by steering and cross-range performance along the ascent trajectory and are not formally constrained.
Downrange Abort Exclusion Zone Figure	 **Figure B-1 Ascent Downrange Abort Exclusion Zone**
Emergency	An unexpected event or events during a mission that requires immediate action to keep the crew alive or serious injury from occurring.

Term	Definition
Emergency Egress	Capability for a crew to exit the vehicle and leave the hazardous situation or catastrophic event within the specified time. Flight crew emergency egress can be unassisted or assisted by ground personnel.
Emergency Equipment and Systems	Systems (ground or flight) that exist solely to prevent loss of life in the presence of imminent catastrophic conditions. Examples include fire suppression systems and extinguishers, emergency breathing devices, Personal Protective Equipment (PPE) and crew escape systems. Emergency systems are not considered a leg of failure tolerance for the nominal, operational equipment and systems, and do not serve as a design control to prevent the occurrence of a catastrophic condition.
Emergency Medical Services	Services required to provide the crewmembers with immediate medical care to prevent loss of life or aggravated physical or psychological conditions.
End of Mission	The planned landing time for the entire mission, including the nominal pre-flight agreed to docked mission duration.
Entry	The period of time that begins with the final commitment to enter the atmosphere from orbit or from an ascent abort, and ending when the velocity of the spacecraft is zero relative to the landing surface.
Entry Interface	The point in the entry phase where the spacecraft contacts the atmosphere (typically at a geodetic altitude of 400,000 feet), resulting in increased heating to the thermal protection system and remainder of the spacecraft exterior surfaces.
External Launch Constraint	Conditions outside the CTS provider's control, such as range weather constraints or faults with range or ISS assets, or weather constraints affecting abort rescue forces capabilities. Range weather examples include ability to visually monitor the initial phases of the launch for range safety, etc. Non-weather range constraints include range safety radar and telemetry systems availability, flight termination systems readiness, clearance of air, land, sea, etc.
Failure	Inability of a system, subsystem, component, or part to perform its required function within specified limits.
Failure Tolerance	The ability to sustain a certain number of failures and still retain capability. A component, subsystem, or system that cannot sustain at least one failure is not considered to be failure tolerant.
Fault	An undesired system state and/or the immediate cause of failure (e.g., maladjustment, misalignment, defect, or other). The definition of the term "fault" envelopes the word "failure," since faults include other undesired events, such as software anomalies and operational anomalies. Faults at a lower level could lead to failures at the higher subsystem or system level.
Flight Configuration	The arrangement, orientation and operational state of system elements and cargo, vehicle cabin layout, flight software mode, and crew complement, clothing and equipment in the applicable mission or ground phase necessary in verification to evaluate the attributes called out in the requirement.
Flight Hardware	All components and systems that comprise the internal and external portions of the spacecraft, launch vehicle, launch abort system, and crew worn equipment.
Flight Operations	All operations of the integrated space vehicle and the crew and ground teams supporting the integrated space vehicle from liftoff until landing.

Term	Definition
Flight Phase	A particular phase or timeframe during a mission is referred to as a flight phase. The term "all flight phases" is defined as the following flight phases: pre-launch, ascent, onorbit free-flight, docked operations, deorbit/entry, landing, and post-landing.
Flight Representative	Description of a test-article used in verifications in which the attributes under evaluation are equivalent to the flight article. Example: Human-in-the-loop tests for spacecraft egress must use an equivalent cabin layout, seats and restraints, and hatch configuration and masses. However, the propulsion system does not need to be functional, as it is not under evaluation.
Flight Rules	Established redline limits for critical flight parameters. Each has pre-planned troubleshooting procedures with pre-approved decisions for expected troubleshooting results.
Flight Systems	Any equipment, system, subsystem or component that is part of the integrated space system.
Flight Termination	An emergency action taken by range safety when a vehicle violates established safety criteria for the protection of life and property. This action circumvents the vehicles' normal control modes and ends its powered and/or controlled flight.
Free Flight Operations	Onorbit operations that occur when the spacecraft is not in contact with any part of the ISS.
Ground Crew	Operations personnel that assist the NASA Crew in entering the spacecraft, closing the hatch, performing leak checks, and working on the integrated space vehicle at the pad during launch operations.
Ground Hardware	All components and systems that reside on the ground in support of the mission, including the Commercial Vehicle Control Center, launch pad, ground support equipment, recovery equipment, facilities, and communications, network, and tracking equipment.
Ground Processing	The work required to prepare the launch vehicle and spacecraft for mission from final assembly/integration/test through launch and resumes after landing for recovery of crew and cargo.
Ground Support Equipment	Any non-flight equipment, system(s), ground system(s), or devices specifically designed and developed for a direct physical or functional interface with flight hardware to support the execution of ground production or processing. The following are not considered to be GSE: • Tools designed for general use and not specifically for use on flight hardware. • Ground Support Systems that interface with GSE Facilities.
Habitable	The environment that is necessary to sustain the life of the crew and to allow the crew to perform their functions in an efficient manner.
Hazard	A state or a set of conditions, internal or external to a system, that has the potential to cause harm.
Hazard Analysis	The process of identifying hazards and their potential causal factors.

Term	Definition
Health and Status Data	Data, including emergency, caution, and warning data, that can be analyzed or monitored describing the ability of the system or system components to meet their performance requirements.
Human Error	Either an action that is not intended or desired by the human or a failure on the part of the human to perform a prescribed action within specified limits of accuracy, sequence, or time that fails to produce the expected result and has led or has the potential to lead to an unwanted consequence.
Human Error Analysis (HEA)	A systematic approach used to evaluate human actions, identify potential human error, model human performance, and qualitatively characterize how human error affects a system. HEA provides an evaluation of human actions and error in an effort to generate system improvements that reduce the frequency of error and minimize the negative effects on the system. HEA is the first step in Human Risk Assessment and is often referred to as qualitative Human Risk Assessment.
Human-in-the-Loop Evaluation	Human-in-the-loop evaluations involve having human subjects, which include NASA crewmembers as a subset of the test subject population, perform identified tasks in a representative mockup, prototype, engineering, or flight unit. The fidelity of mockups used for human-in-the-loop evaluations may range from low-fidelity, minimal representation, to high-fidelity, complete physical and/or functional representation, relevant to the evaluation. Ideally, the fidelity of human-in-the-loop mockups and tests increases as designs mature for more comprehensive evaluations. Further information on human-in-the-loop evaluations throughout system design can be found in JSC 65995 CHSIP.
Human-System Integration	The process of integrating human operations into the system design through analysis, testing, and modeling of human performance, interface controls/displays, and human-automation interaction to improve safety, efficiency, and mission success.
Ill or Injured	Refers to a crewmember whose physiological and/or psychological well-being and health has deteriorated as a result of an illness (e.g., appendicitis) or injury (e.g., trauma, toxic exposure) and requires medical capabilities exceeding those available on the ISS and transportation to ground-based definitive medical care. Ill or injured crewmember performance for nominal and off-nominal mission tasks will be degraded.
Inspection	A method of verification that determines conformance to requirements by the use of standard quality control methods to ensure compliance by review of drawings and data. This method is used wherever documents or data can be visually used to verify the physical characteristics of the product instead of the performance of the product.
Integrated Operations	All operations starting at 90 minutes prior to the ISS Approach Initiation and lasting until the vehicle leaves the ISS Approach Ellipsoid on a non-return trajectory.
Integrated Space Vehicle	The integrated space vehicle includes all flight elements physically connected for the phase of flight from post lift-off until spacecraft separation.
Landing	The final phase or region of flight consisting of transition from descent to an approach, touchdown, and coming to rest.

Term	Definition
Landing Site	**Supported Landing Sites:** A fully supported site on a Continental U.S. land mass or waters directly extending from the coast with CTS recovery forces on station at the time of landing. The landing site zone extends through nominally expected dispersions from the landing site point. Designated Primary Landing Site – A supported landing site-intended for landing at the time of spacecraft undock. Alternate Landing Site – A supported landing site to which the spacecraft landing can be diverted in the event the deorbit burn is delayed. **Unsupported Landing Sites:** Emergency Landing – Any unsupported site (land or water) arrived at due to critical failures that force immediate return and preclude landing at a designated primary or alternate landing sites.
Launch Commit Criteria	Established redline limits for critical launch parameters. Each has pre-planned troubleshooting procedures with pre-approved decisions for expected troubleshooting results.
Launch Opportunity	The period of time during which the relative position of the launch site, the ISS orbital plane, and ISS phase angle permit the launch vehicle to insert the spacecraft into a rendezvous trajectory with the ISS (northerly launches only due to range constraints). The ISS is in-plane with the Eastern Range approximately every 23 hours and 36 minutes.
Launch Probability	The probability that the system will successfully complete a scheduled launch event. The launch opportunity will be considered scheduled at 24 hours prior to the opening of the launch window.
Launch Vehicle	The vehicle that contains the propulsion system necessary to deliver the energy required to insert the spacecraft into orbit.
Life-Cycle	The totality of a program or project extending from formulation through implementation, encompassing the elements of design, development, verification, production, operation, maintenance, support, and disposal.
Loss of Crew	Death or permanently debilitating injury to one or more crewmembers.
Loss of Mission	Loss of, or the inability to complete enough of, the primary mission objectives, such that a repeat mission must be flown.
Maintenance	The function of keeping items or equipment in, or restoring them to, a specified operational condition. It includes servicing, test, inspection, adjustment/alignment, removal, replacement, access, assembly/disassembly, lubrication, operation, decontamination, installation, fault location, calibration, condition determination, repair, modification, overhaul, rebuilding, and reclamation.
Manual Control	The crew's ability to bypass automation in order to exert direct control over a space system or operation. For control of a spacecraft's flight path, manual control is the ability for the crew to affect any flight path within the capability of the flight control system. Similarly, for control of a spacecraft's attitude, manual control is the ability for the crew to affect any attitude within the capability of the flight/attitude control system.

Term	Definition
MCC-H Mission Authority	• MCC-H has authority to make final decisions regarding spacecraft operations, including but not limited to Go/No-Go decisions and safety of flight and crew(s). • Beginning with either ISS integrated operations, or 30 minutes before the first required ISS configuration or crew activity in support of the spacecraft on rendezvous (e.g., ISS attitude maneuver, appendage configuration, USOS GPS configuration), whichever comes first. • Ending with either the end of ISS integrated operations, or when ISS is not required to maintain its configuration (e.g., ISS attitude, USOS GPS configuration, or appendages in a configuration) to support the spacecraft, whichever comes later. • Applies anytime the spacecraft free-drift trajectory, including dispersions, is predicted to enter the ISS AE within the next 24 hours.
Mission	The mission begins with entry of the crew into the spacecraft, includes delivery of the crew to/from ISS, and ends with successful delivery of the crew to NASA after landing.
Mission Critical	Item or function that must retain its operational capability to assure no mission failure (i.e., for mission success).
NASA Crew	The NASA crewmembers or the NASA sponsored crewmembers. These include international partner crewmembers.
Operations Personnel	All persons supporting ground operations or flight operations functions of the CTS. Examples of these personnel are listed below: Persons responsible for the production, assembly/integration/test, validation, and maintenance of flight hardware, production facilities, launch site facilities, operations facilities, or ground support equipment (GSE). Persons involved with supporting or managing the launch countdown, crew training, or mission during flight. Persons involved in post-flight recovery.
Orbit	This flight phase starts just after final orbit insertion and ends at the completion of the first deorbit burn.
Non-Standard Open Work	Work that is not a part of the normal standard work process.
Override	To take precedence over system control functions.
Pad Abort	An abort performed where the crewed spacecraft is separated from the launch vehicle while the launch vehicle remains on the launch pad. As a result, the crewed spacecraft is safely transported to an area which is not susceptible to the dangers associated with the hazardous environment at the launch pad.
Permanent Disability	A non-fatal occupational injury or illness resulting in permanent impairment through loss of, or compromised use of, a critical part of the body, to include major limbs (e.g., arm, leg), critical sensory organs (e.g., eye), critical life-supporting organs (e.g., heart, lungs, brain), and/or body parts controlling major motor functions (e.g., spine, neck). Therefore, permanent disability includes a non-fatal injury or occupational illness that permanently incapacitates a person to the extent that he or she cannot be rehabilitated to achieve gainful employment in their trained occupation and results in a medical discharge from duties or civilian equivalent.

Term	Definition
Portable Fire Suppression System	A system comprised of one or more portable handheld fire extinguishers and access ports. These access ports allow the user to discharge fire suppressant into enclosed areas with potential ignition sources. See also 3.10.12.2 Use of Hazardous Chemicals.
Post-Landing	The mission phase beginning with the actual landing event when the vehicle has no horizontal or vertical motion relative to the surface and ending when the last crewmember is loaded on the aircraft for return to JSC.
Process Witnessing	A physical observation of each Commercial Provider's work processes or demonstrations (including tests) to ensure compliance with documented procedure(s) and contract requirements. Includes processes related to manufacturing, fabrication, assembly, integration, repair, maintenance, refurbishment, test, and inspection.
Product Assurance Action	A mandatory Government surveillance activity focusing on a particular aspect of the Commercial Provider's integrated CTS where the government assures the product or service being delivered meets the requirements as defined by the CCP. A PAA can be accomplished by performing the following: audit, process witness, product examination, or record review.
Product Examination	A physical inspection, measurement, or test to ensure product conformity to prescribed technical and contract requirements. This method may also include Engineering's independent Verification and Validation of an analysis, model, simulation, or test results.
Proximity Operations	The flight phase including all times during which the vehicle is in free flight beginning just prior to Approach Initiation (AI) execution and ending when the vehicle leaves the Approach Ellipsoid (AE).
Quiescent Docked Operations	The state of the CTS spacecraft while it is docked to the ISS with hatches open and ISS services, as called out in SSP 50808, connected and operational. From this state, the vehicle can support immediate ingress and transition into safe haven in the case of an emergency.
Record Review	A review and verification that recorded data properly evidences conformance to contract requirements (e.g., invoked drawings, specifications). Recorded data, including contractually required data deliverables, may document work performance, product attributes, product configuration, product performance, or quality assurance actions performed by each Commercial Provider.
Recovery	The process of proceeding to a designated nominal landing site, and retrieving crew, flight crew equipment, cargo, and payloads after a planned nominal landing.
Reliability	The probability that a system of hardware, software, and human elements will function as intended over a specified period of time under specified environmental conditions.
Rendezvous	The flight phase of executing a series of onorbit maneuvers to move the spacecraft into the proximity of its target. This phase starts with orbit insertion and ends just prior to the approach initiation.

Term	Definition
Risk Based Analysis (RBA)	A risk tool, whose application for CCP, is to independently assess all Commercial Providers' safety-critical attributes (areas, processes) for completeness, and adequate r878787esidual risk mitigation for all Program phases. It assigns *Government Quality Assurance* functions to any attribute (process, area) determined by the analysis to have residual risk which requires additional mitigation. It is an *iterative* analysis, updated as the Commercial Provider-specific risk changes, and is based on a comprehensive understanding of the design, development, test, critical manufacturing / assembly processes, and operations.
Safe Haven	A functional association of capabilities and environments that is initiated and activated in the event of a potentially life-threatening anomaly and allows human survival until rescue, the event ends, or repair can be affected. It is a location at a safe distance from or closed off from the life-threatening anomaly.
Safety	The absence from those conditions that can cause death, injury, occupational illness, damage to or loss of equipment or property, or damage to the environment.
Safety Critical	A condition, event, operation, process, function, equipment or system (including software and firmware) with potential for personnel injury or loss, or with potential for loss or damage to vehicles, equipment or facilities, loss or excessive degradation of the function of critical equipment, or which is necessary to control a hazard.
Search and Rescue	The process of locating the crew, proceeding to their position, and providing assistance.
Software	Computer instructions or data stored electronically. Systems software includes the operating system and all the utilities that enable the computer to function. Applications software includes programs that do real work for users, such as word processors, spreadsheets, data management systems, and analysis tools. Software can be Commercial Off-The-Shelf (COTS), contractor developed, Government furnished, or combinations thereof.
Spacecraft	All system elements that are occupied by the crew during the space mission and provide life support functions for the crew. The crewed element includes all the subsystems that provide life support functions for the crew.
Space System	The collection of all space-based and ground-based systems (encompassing hardware and software) used to conduct space missions or support activity in space, including, but not limited to, the integrated space vehicle, space-based communication and navigation systems, launch systems, and mission/launch control.
Standard Open Work	Open work that is known in advance and which cannot be completed until some planned future event.
Standard Work	Work that occurs at part of the normal planned process.
Stowage	The accommodation of physical items in a safe and secure manner in the spacecraft. This does not imply that resources other than physical accommodations (e.g., power, thermal, etc.) are supplied.

Term	Definition
Subsystem	A secondary or subordinate system within a system (such as the spacecraft) that performs a specific function or functions. Examples include electrical power, guidance and navigation, attitude control, telemetry, thermal control, propulsion, structures subsystems. A subsystem may consist of several components (hardware and software) and may include interconnection items such as cables or tubing and the support structure to which they are mounted.
System	The aggregate of the ground segment, flight segment, and workforce required for crew rescue and crew transport.
Task Analysis	Task analysis is an iterative human-centered design process through which user tasks are identified and analyzed. It involves 1) the identification of the tasks and subtasks involved in a process or system, and 2) analysis of those tasks (e.g., who performs them, what equipment is used, under what conditions, the priority of the task, dependence on other tasks). The focus is on the human and how they perform the task, rather than the system. Results can help determine the hardware or software that should be developed/used for a particular task, the ideal allocation of tasks to humans vs. automation, and the criticality of tasks, which drive design decisions. Further information on task analysis can be found in JSC 65995 CHSIP, Section 4.1.
Test	A method of verification in which technical means, such as the use of special equipment, instrumentation, simulation techniques, and the application of established principles and procedures, are used for the evaluation of components, subsystems, and systems to determine compliance with requirements. Test will be selected as the primary method when analytical techniques do not produce adequate results; failure modes exist, which could compromise personnel safety, adversely affect flight systems or payload operation, or result in a loss of mission objectives. The analysis of data derived from tests is an integral part of the test program and should not be confused with analysis as defined above. Tests will be used to determine quantitative compliance to requirements and produce quantitative results.
Time-Critical Cargo	Cargo that requires late stowage pre-launch (within 24 hours of launch) and early removal post-landing (within 1 hour of crew egress).
Transport	Launch of crew and cargo to and return from the ISS.
Validation	Proof that the product accomplishes the intended purpose. May be determined by a combination of test, analysis, and demonstration.
Verification	Proof of compliance with a requirement or specifications based on a combination of test, analysis, demonstration, and inspection.

Appendix C: Commercial Provider Expectations for Certification

This appendix describes the elements that comprise Certification expectations for the Commercial Provider. As stated in Section 3.0, the Commercial Provider is responsible for DDT&E which supports their assertion of meeting the CTS requirements. NASA CCP is accountable for assuring compliance to the NASA Crew Transportation System requirements for the ISS DRM as documented in CCT-REQ-1130, the technical management plans and process requirements as documented in CCT-PLN-1120, and relies on the ISS Program to assure compliance to SSP 50808. This appendix is broken into the major elements that together encompass the total Certification of the CTS. Section C1.0 will discuss elements of production and operation as critical to successful design. In Section C2.0, the discussion will focus on the attributes of Certification related to production. Finally, Section C3.0 will discuss the details of successful operational elements.

C1.0 The Design Element

The Design element of Certification is a broad term to encompass many design activities and processes that allow NASA to approve the use of a system. Certification can only occur after establishment of a design baseline post-CDR (critical design review), and after all analysis and qualification testing have been completed, including all modifications needed for qualification-caused corrective actions. An item built to the design definition and intended for testing to verify a requirement is often called a qualification article. Similarly, a test performed on a qualification article is often called a qualification test.

C1.1 Verification that a Design Meets Requirements

Verification methods include test, analysis, inspection, demonstration, or combinations of these methods. To establish that a design meets requirements, verification methods are determined, planned and conducted, and results are assessed. A system is characterized by a product breakdown structure (PBS), with example PBS levels being "system-element-modules-subsystem-units-component." Verification is conducted at the levels of configuration necessary to comply with the applicable requirements. A set of requirements, as defined in CCT-REQ-1130, contain individual requirements written at different levels of the PBS, such as system requirements for integrated performance and subsystem requirements for specific functional performance of a subsystem. Requirements are allocated down by the providing organization to the lowest level necessary in the PBS to accomplish a function or meet an objective. Requirements derived from hazard analyses as hazard controls are considered program level derived requirements and are expected to be treated like program level specified requirements within the Commercial Provider's Certification. These controls are implemented in design, production, and operations (all three elements of the Certification activities). Verifications are performed at the allocated level and as necessary at the next higher assembly level. The verifications at the higher assembly level may be analysis of the integrated performance at that level based on the results of verification at the level below. Verification of the allocated requirement is rolled up to prove that the system meets the requirement. To support the roll up of verifications at the top level of the PBS, data products at the lowest level of allocated performance are identified and are available to support Commercial Provider Certification recommendations.

Verification that a design meets requirements includes any necessary functionality and performance during exposure to environmental conditions (e.g., vibration, temperature, pressure) that the item will be subject to during all phases of the service life. The service life extends from the completion of

fabrication to final disposal of the item and includes all acceptance test environments (including those experienced during higher assembly level acceptance testing), handling, transportation, storage, ground operations, flight, and recovery. Qualification testing is generally conducted with margin beyond the design specification required conditions with respect to amplitudes, cycles, or duration of exposure. This type of testing is done to account for unit-to-unit variability in the flight production hardware, to justify allowable test tolerances, and to demonstrate an overall robustness of the design to withstand the environmental conditions expected throughout the service life. These as-qualified conditions (i.e., with the margin) are not to be considered the certified conditions. In other words, the item is qualified with margin beyond the specification required conditions in order to certify the design to the specification required conditions.

In order for verification (by any method) to be valid, it must be conducted on an article or model representative of the design to be certified. To verify a requirement by test, the test must be conducted on an item that has been produced in accordance with the design definition for those attributes where test results would be used as verification evidence. In addition, the test equipment or test facility must be shown to be capable of conducting a test that exposes the item under test to the conditions necessary to simulate the environment and measure the results. This is covered in more detail later in Section C1.4. To verify a requirement by analysis, the analysis must be conducted on an item (model, schematic, etc.) that represents the design attributes being analyzed. And as with test verification, the analysis tools must be capable of producing results that are valid. This is also covered in more detail later in Section C1.4.

The use of commercial off the shelf (COTS) items or heritage flight systems is always an option for spaceflight Certification. The process for use and Certification of these items includes evaluation of the past usage against the current requirements in the envisioned integrated system and design environment. In order to utilize COTS or heritage flight systems, an analysis must be performed of the previous usage and Certification to determine that the item is used within the same integrated environments and operations that it was designed and certified for and that the user understands that the item is the same as what was previously used. Additional testing may be required to show acceptance for the CTS application.

C1.2 Validity of the Processes that Create the Design Definition

The design definition includes extensive information produced to document the design, such as drawings, manufacturing models, analysis models, interface models, assembly procedures, special process instructions, specification sheets for parts or materials, and sampling procedures. The processes used to create these individual information products must be credible and repeatable. Examples include code written to translate CAD model data into manufacturing machine control language or auto code for producing software. These articles of design definition must be credible in order to produce the resulting product.

In addition to the tools that produce the design definition, the establishment of consistent use of source data and use of that source data within different design definition articles must be understood. CAD models used to define and produce the design, along with mathematical models used to define and analyze the design, must be consistent with the design source data. Changes to the design definition articles must flow into the models used for analysis and production in a controlled and repeatable process in which articles must be changed and re-analyzed based on a change from the last design cycle. Material property information is utilized as a basis in an analysis, and the material property utilized in

the analysis must match the material property identified in the CAD models, drawings, and processes utilized to produce the end item or utilized in the end item. If the material property is changed in the CAD model or production plan, the analysis must be changed to account for the different material property and re-run to determine that the design still meets the requirements.

C1.3 Validity of the Processes that Produce the System

The system will be produced in accordance with the design definition. When the processes used to produce the end item do not maintain the production process in accordance with the intent of the design definition, the product may not represent the design. Processes that produce the system may impart unintended stresses or flaws in the product that will not be detected by inspection and test. Not all end items can be inspected, and testing does not expose items to all the environments, simultaneous environmental stresses, or functional performance that could detect a flaw prior to flight. Understanding the capability, repeatability, and weaknesses in the processes that produce the end item allows the design, manufacturing, and test organization to establish the test, inspection, and sampling requirements that have the best opportunity to identify and prevent flaws. The processes that produce the system must be capable of producing products that meet the tolerances and critical attributes in the design definition.

The processes that produce the system must account for additional factors such as material selection and control; mechanical and electrical parts management processes; metrology and tool calibration; control of manufacturing tools and test equipment; coupon and lot sample testing of materials and special processes; limited life identification and tracking; separation of flight and non-flight stock; and control of flight hardware from unauthorized and un-recorded activities that could damage or remove cycle life. When a system contains items that are re-used or refurbished, additional processes are necessary. In addition to the processes that produced the system, additional processes such as refurbishment and Non-Destructive Evaluation (NDE) procedures, fair wear and tear, limited life tracking, and standard repair procedures are established to ensure that the item is capable of performing an additional mission.

C1.4 Validity of the Tools that Verify the Design

In order to use the results of a verification method, the method must be performed on an article representative of the design. To verify a requirement by test, the test must be conducted on an item that has been produced in accordance with the design definition for those attributes where test results would be used as verification evidence. In addition, the test equipment or test facility must be shown to be capable of conducting a test that exposes the item under test to the conditions necessary to simulate the environment and measure the results. Flight and ground test, with appropriate instrumentation, are typically needed to validate environments, functionality, system performance, and margins.

As an example, a facility that performs a vibration test must be able to expose the item under test to the frequencies at amplitude within a test tolerance that is pre-defined in the design specification, and documented in the test procedure. The facility must be able to measure and record the input excitation and the response. If the test facility cannot control the excitation to within the test tolerances for the amplitude (e.g., +/- 1.5dB), and measurement equipment does not have the resolution (e.g., an order of magnitude) to determine that the item was maintained between the tolerance, the item may not be exposed to the required environment, and the verification data would be invalid even though the procedure and report would indicate that it met the requirement.

Similarly, a typical method for spacecraft verification by analysis is simulation of trajectories and critical events. The simulation must be shown to model the design definition including critical components and environments. Uncertainty factors are defined to account for possible deficiencies in model or simulation fidelity, variabilities that cannot be deterministically defined and sensitivities that cannot be accurately predicted. The simulation component and environment models are based on validated test data. For instance, the validated data from the vibration test above may be used to build a flex model which is incorporated into a dynamics simulation.

NDE is used in many cases to detect flaws. The critical attributes of a flaw (crack size, surface contour, etc.) must be within the capability of the NDE method, the capability of the NDE operator, and the capability of the system that presents the resulting data.

C1.5 Control of the Design Definition

Management systems that define and control implementation processes are necessary to certify that produced products are understood and are representative of the design. The Program Management Plan will describe the organizational structure, along with roles, responsibilities, and relationships for managing systems engineering processes and tools to ensure requirements are properly flowed down into the Commercial Provider's system. Relevant sub-tier plans will address processes control of critical functions including quality management, procurement quality, configuration management, material control, requirements management, and risk management. Sub-tier plans will also address interface management between elements of the Commercial Provider CTS and interfaces with external elements. These sub-tier plans represent various levels of risk in the form of limitations in the Commercial Provider's ability to manage inherent risks.

Configuration control is key to defining hardware and software configuration from baselining of all products at initial release of the PBS to completion of final Certification and CoFR. Configuration control is key to ensuring that the correct system is built and that improper substitutions were not made. Configuration control of training and operational products used to operate the hardware and software is also necessary to ensure that the System is not operated out of its certified design range. Changes at the part number level have to be controlled through a rigorous process to ensure test articles are representative of the flight hardware/software design. These changes through the processes are then valid for development and verification, and the production of flight units that represent the certified design. The Commercial Provider will define the level of upward and downward traceability imbedded in the configuration control which enables corrective actions in response to deficiencies detected in testing, in vendor identified defects, and operating anomalies.

The design definition must be controlled to understand changes that are made and the impact to the Certification. Design drawings must be controlled so that a change to a drawing that affects the form, fit, or function of that item or its production process is given a different designation (such as a different dash number or configuration item identifier) from the original drawing (part) number. Operational differences can then be reflected in the training and operational products. Analysis models and reports must be controlled so the basis of the analysis and the results of the analysis are identified appropriately between the analysis and the system configuration under analysis. Changes to the analysis basis must be reflected in the configuration identification and processes that produce the end item. Material property information is utilized as a basis in an analysis. The material property employed in the analysis must match the material property identified in the drawings and processes utilized to produce the end item or

utilized in the end item. Any change to the material property in any of the design definition must be controlled so that the change is properly accounted for in all design definition and the impact of change is understood and agreeable by the affected functional disciplines.

C2.0 The Production Element

Production Certification is the confirmation that a Commercial Provider's production process will result in properly integrated "as-built" elements of the system that match the overall physical CTS design or "print." This confirmation assures the elements will meet the performance, safety, reliability, and quality requirements established and verified at the functional level. The scope of this element of the CTS Certification applies to the hardware and software associated with production tooling, test equipment, qualification article(s), flight test articles, and all production articles. Certification of personnel and processes used to create the production articles are also included in the scope. Since the production processes derived for the qualification and first flight articles apply to all articles produced with the scope of this element of Certification, this section of the plan is closely linked with maintenance of the Certification described in Section 5.0.

The Commercial Provider's Production Certification emphasis will be on production and assembly processes that implement critical attributes; failure tolerance, redundancy, and hazard controls; and the tests, analyses, demonstrations, and/or inspections supporting the verification of the as-built CTS.

Certification of the System and ability to endorse flight readiness relies on knowing that the products produced and identified by that certified configuration are controlled. This means that those products have gone through all that was originally required, and that there have not been changes or elimination of necessary steps. The basis of why Certification was granted can be affected by manufacturing and special process changes; changes to assembly procedures, which include critical processes; and inspection and testing, which have been identified as part of the design Certification. Lessons learned from past programs have highlighted areas where deficiencies in control and screening of hardware resulted in erosion of design margins to the point of failure.

Production critical planning, processes, and inspections, utilized to manufacture flight articles or maintain reusable elements must be compatible with the Commercial Provider's hardware and software design and producibility definition. The production system will include a quality management system that meets the intent of AS9100. During manufacturing, despite best efforts in production Certification and process control, there will inevitably be unplanned deltas between the "as-designed" and "as-built" hardware or software elements. These departures will need to be eliminated through rework or ultimately deemed acceptable. Departures ranging from minor deviations from normal or expected results, to clear deviations from the engineering requirements, or material/part substitutions, are typically documented and resolved through a Commercial Provider process known as a non-conformance process. Dispositions to non-conformances typically involve either rework intended to return hardware to print, and/or accepting changes to the "as-designed" configuration of the hardware, following review and evaluation. These resolutions often involve exceptions to approved designs or production processes, which are documented through a Commercial Provider approved Material Review Board (MRB) and/or waiver/deviation process. Approval of exceptions will depend on a healthy MRB process established by the Commercial Provider, and could have maintenance implications on the Commercial Provider's design, production, or operations Certification. Furthermore, non-conformance resolutions must continue to comply with management process requirements for maintaining accurate

records of the “as-built” CTS configuration, and for maintaining appropriate levels of production traceability.

A key component of production control is product acceptance by the Commercial Provider. Product acceptance is the verification activity that demonstrates that each flight-item produced performs in accordance with requirements and has been fabricated with acceptable quality and workmanship. Product acceptance is usually accomplished with in-process checks as well as formal demonstrations, inspections, and tests of the final flight configuration at a defined assembly level (i.e., a unit, a subsystem, etc.). Formal acceptance tests are performed on the final assembly level to confirm acceptable functionality and performance. Environmental acceptance tests, usually comprised of vibration and thermal cycling and/or thermal vacuum, are utilized as environmental stress screens to precipitate latent manufacturing or material defects into detectable failures so that they may be corrected prior to delivering the item to the next higher level of integration. Formal acceptance test begins at the unit level of assembly and progresses through higher levels of assembly as appropriate up to the final highest level of integrated assembly.

C3.0 The Operational Element

CTS Certification includes the confirmation that operational plans, processes, procedures, and operational support systems are consistent with the design of the flight elements and will result in operations which meet mission requirements, while remaining within the constraints established by the verified and validated capabilities of hardware, software, and humans involved. Processes defined for operational authority, such as risk acceptance, material reviews, variances, etc. should be included in operational Certification.

Early in the design phase, operational concepts are developed by the Commercial Provider which influences the design of flight systems and ground architecture. As these design elements mature, so do the operational concepts. By CDR, operational techniques are proposed that work in concert with the hardware and software designs. NASA expects the Commercial Provider to document these maturing operational concepts and architectures in periodically updated operations concepts documents and in baseline operations plans, which describe the operational support facilities, personnel performing operations in those facilities, and mechanisms to define and control operational processes. System operational constraints include hardware and software operating envelopes that are derived to ensure the performance and safety requirements are met.

CCT-STD-1150 documents the criteria and practices expected of the Commercial Provider for human spaceflight operations and describe the basis for the operational assessments for certification. The scope of the CTS Operations portion of Certification includes those activities associated with production; processing; assembly, integration and test; launch preparation; launch countdown; pre-flight planning and product development; training of flight crews and operations personnel; integrated space vehicle and subsystem performance analysis; mission execution and operations support; and landing and recovery support.

The evidence for Certification associated with Operations is collected by the Commercial Provider throughout the design and production timeframes and is reviewed at the DCR and delta DCRs.

Operations facilities are reviewed to assure that mission critical infrastructure can support the missions and interface with external operational facilities such as the ISS mission control center, Eastern Range, STRATCOM, etc., and doesn't invalidate flight hardware certification. Operational facilities Certification evidence consists of Commercial Provider verification of planning, training, and real-time control. Hazard controls that are operationally managed will be established by the Commercial Provider and the Commercial Provider will verify successful implementation of these controls. Ground and flight crew nominal and contingency procedures are validated and reviewed for completeness. Mission execution constraints are documented in products such as Launch Commit Criteria and/or Flight Rules.

Appendix D: Agency, Center, and Technical Authority Certification Statements

Consistent with the Agency governance framework defined in NPD 1000.0B and the NASA CTS certification philosophy defined in HEOMD-CSD-10001, this Appendix defines the Agency CTS Certification Approval statement and the supporting Concurrence statements from the Center Directors and the Technical Authorities.

Approval	
NASA Associate Administrator	The Certification Review Board has conducted a comprehensive assessment of the Commercial Provider's certification assertion of the CTS flight and ground systems and supporting personnel. The Certification Review Board has also conducted a comprehensive assessment of the Commercial Provider's certification assertion of the integrated CTS, including the certification of the launch vehicle, spacecraft, ground, and mission operations to NASA's CTS requirements documented in HEOMD-CSD-10001. This Certification has been approved by both the CCP and ISS Program and the AA SOMD. I have concluded, with the concurrence of the Certification Review Board and the AA SOMD that the design of the Commercial Provider's integrated CTS, including the technical management processes to produce, manufacture, and operate the CTS, meets NASA's human rating requirements for the ISS Design Reference Mission. I have accepted any residual technical risks inherent to the design and I have weighed all formal dissents as part of this decision. I authorize the approval of the Commercial Provider's CTS Certification.
NASA Associate Administrator for Space Operations Mission Directorate	The Certification Review Board has conducted a comprehensive assessment of the Commercial Provider's certification assertion of the CTS flight and ground systems and supporting personnel. The Certification Review Board has also conducted a comprehensive assessment of the Commercial Provider's certification assertion of the integrated CTS, including the certification of the launch vehicle, spacecraft, ground, and mission operations to NASA's CTS requirements documented in HEOMD-CSD-10001. This Certification has been approved by both the CCP and ISS Program. I have concluded, with the concurrence of the Certification Review Board that the design of the Commercial Provider's integrated CTS, including the technical management processes to produce, manufacture, and operate the CTS, meets NASA's human rating requirements for the ISS Design Reference Mission.
Concurrence	
Director, JSC	I have determined, with inputs from the Technical Authorities, that the technical management processes and requirements documented in CCT-PLN-1120, CCT-REQ-1130, and SSP 50808 have been adhered to, and that technical requirement variances to NASA's CTS requirements, documented in the aforementioned documents for the CTS within the assigned technical responsibility and cognizance of my Center have been satisfactorily dispositioned and that associated residual technical risks inherent to the design have been appropriately characterized and assessed as reasonable by the technical authorities in support of the Program's risk acceptance decision.

	I have also determined, with input from the Technical Authorities, including Flight Operations, serving as the technical authority for the NASA Crew that the design of the Commercial Provider's integrated CTS, including the technical management processes to produce, manufacture, and operate the CTS, meets NASA's human rating requirements for the ISS Design Reference Mission.
Director, KSC	I have determined, with inputs from the Technical Authorities, that the technical management processes and requirements documented in CCT-PLN-1120, CCT-REQ-1130, and SSP 50808 have been adhered to, and that technical requirement variances to NASA's CTS requirements, documented in the aforementioned documents for the CTS within the assigned technical responsibility and cognizance of my Center have been satisfactorily dispositioned and that associated residual technical risks inherent to the design have been appropriately characterized and assessed as reasonable by the technical authorities in support of the Program's risk acceptance decision.
Director, MSFC	I have determined, based on my Center's focused evaluation of the Commercial Provider's flight system design and their process assessments, that the Commercial Provider has provided adequate evidence under the shared assurance operational model of meeting the requirements documented in CCT-PLN-1120, CCT-REQ-1130, and SSP 50808, and has adhered to the technical management processes therein. I have also determined, within the assigned technical areas of responsibility and cognizance for my Center, that alternate standards and technical requirement variances to the above requirements have been satisfactorily dispositioned and implemented, and that the remaining identified safety risks associated with these systems have been assessed in support of the Program's risk acceptance decision.
Agency Chief Engineer	I have reviewed the critical aspects to the design, production, manufacturing, and operations related to Flight Safety and concur that the Engineering technical requirements and applicable standards/specifications documented in CCT-PLN-1120, CCT-REQ-1130, and SSP 50808 have been met and technical requirement variances related to Engineering requirements documented in the aforementioned documents have been satisfactorily reviewed and dispositioned, and that residual safety of flight technical risk due to hazards, waivers, non-compliances, etc. inherent to the design, production, manufacturing, and operations requirements and processes have been appropriately characterized and assessed as reasonable by the Engineering technical authority in support of the Program's risk acceptance decision.
Agency Chief Safety Officer	I have reviewed critical aspects to the design, production, manufacturing, and operations related to Safety and Mission Assurance and concur that the technical management processes and requirements documented in CCT-PLN-1120, CCT-REQ-1130, and SSP 50808 have been met and technical requirement variances related to Safety and Mission Assurance requirements documented in the aforementioned documents have been satisfactorily reviewed and dispositioned, and that residual technical risk due to hazards, waivers, non-compliances, etc. inherent to the design, production, manufacturing, and operations requirements and processes have been appropriately characterized and assessed as reasonable by the Safety and Mission Assurance technical authority in support of the Program's risk acceptance decision.

Agency Chief Health and Medical Officer	I have reviewed critical aspects to the design, production, manufacturing, and operations related to CTS Human Health and Performance and concur that the technical management processes and requirements documented in CCT-PLN-1120, CCT-REQ-1130, and SSP 50808 have been met and technical requirement variances related to CTS Human Health and Performance requirements documented in the aforementioned documents have been satisfactorily reviewed and dispositioned, and that residual technical risk due to hazards, waivers, non-compliances, etc. inherent to the design, production, manufacturing, and operations requirements and processes have been appropriately characterized and assessed as reasonable by the Health and Medical technical authority in support of the Program's risk acceptance decision.

Appendix E: Certification Approval and Commercial Provider Certification Substantiation

This Appendix defines the Program's CTS Certification Approval statement, the supporting concurrence statements from the NASA Organizations and the Technical Authorities, and the Commercial Provider's Substantiation. Prior to the Agency CR, each identified role will sign the applicable certification approval statements listed below.

Approval	
Manager, CCP	The Commercial Provider has certified the CTS for the ISS DRM. CCP has approved of all VCNs and Hazard Reports under CCP responsibility. All required NASA approved Commercial Provider plans are in place and implemented in accordance with CCT-PLN-1120. Deviations, exceptions, or waivers to CCP's requirements (CCT-REQ-1130) have been approved. The Commercial Crew Program substantiates the Commercial Provider's certification assertion.
Manager, ISS Program	The Commercial Provider has certified the CTS for the ISS DRM. ISS has approved of all VCNs and Hazard Reports under ISS Program responsibility. Deviations, exceptions, or waivers to ISS requirements (CCT-REQ-1130i and SSP 50808) have been approved. The International Space Station Program substantiates the Commercial Provider's certification assertion.
Concurrence	
NASA Organizations	The Certification Process documented in CCT-PLN-2000, NASA CTS Certification Plan, has been satisfied. Review of required products and verifications for each organization have been completed. The following NASA organizations have completed audit, insight, and approval of the applicable Commercial Provider activities and deliverables, and have resolved all discrepancies. Government furnished services have been verified to meet the requirements to enable the Commercial Provider activities, as applicable. CCP Ground and Mission Operations CCP Integrated Performance Office CCP Launch Vehicle Office CCP Mission Management and Integration Office CCP Program Control and Integration Office CCP Spacecraft Office CCP Systems Engineering and Integration Office CCP Chief Engineer CCP Chief Safety and Mission Assurance Officer HMTA Delegate for Commercial Crew Program Flight Operations Directorate ISS Program Transportation Integration Office Based on the satisfaction of the review requirements applicable to my organization, I concur with the Certification assertion.

Commercial Provider Substantiation	
Manager, Commercial Provider	The NASA approved Commercial Provider CTS Certification and Verification and Validation Plans have been satisfied. All anomalous conditions impacting CTS Certification have been identified and resolved with NASA. The CTS design, production, manufacture and operations are certified to be in accordance with NASA's requirements for the ISS Design Reference Mission (CCT-REQ-1130 and SSP 50808) and management policies defined in CCT-PLN-1120.

Appendix F: CCP Office Certification Statements

This Appendix identifies the Certification Themes and Statements that must be satisfied by CCP to assure the Commercial Provider's CTS Certification. This list also provides an organizational cross-reference matrix between the Certification Statements and the certifying CCP Office. Each Office concurs on each statement from their office perspective. CCP SE&I is responsible for ensuring the overall Certification theme is met.

Theme	Certification Statement	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
Programmatic								
a. NASA has performed a compliance assessment to the HEOMD-CSD-10001 requirements. All waivers, deviations, or exceptions from the requirements have been dispositioned and accepted.	a.1 The Human Rating Certification Data Package has been developed and submitted for approval to the Associate Administrator of the Space Operations Mission Directorate (SOMD).	X	N/A	N/A	N/A	N/A	N/A	N/A
b. All certification and technical management plans and processes required in CCT-PLN-1120 have been completed.	b.1 Commercial Provider Certification Plan has been approved and NASA Insight indicates the Commercial Provider's implementation is in compliance with the approved Certification Plan.	X	N/A	N/A	N/A	N/A	N/A	N/A
	b.2 Commercial Provider Management Plans are approved and all adverse implementation and control processes items identified by NASA insight have been resolved.	X	X	X	X	X	X	X

Theme	Certification Statement	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
	b.3 Commercial Provider Verification and Validation plan has been approved and all adverse items identified by NASA insight have been resolved.	X	N/A	N/A	X	X	X	X
c. All risk management activities have been completed or documented as acceptable.	c.1 All open items and actions from major certification reviews (including CBR, DCR, ORR) have been resolved and closed.	X	X	X	X	X	X	X
	c.2 The Commercial Provider's risks applicable to Certification and subsequent missions have been reviewed and they have been closed.	X	X	X	X	X	X	X
d. All Government Provided Services have been verified to meet the functional and performance requirements.	d.1 All Government Provided Services have been verified to meet the functional and performance requirements. Any exceptions from the requirements have been approved.	N/A	N/A	N/A	N/A	N/A	X	N/A
Design								
e. The design of the CTS HW/SW has been verified to meet the functional and performance requirements in the design-to specifications and will support crew and cargo transportation. Any exceptions, waivers, or deviations from the requirements have been approved.	e.1 Reserved	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Theme	Certification Statement	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
	e.2 Commercial Provider Flight Test Plan objectives needed for validation and confirmation of integrated system capability have been met, anomalies have been resolved and lessons learned incorporated.	N/A	X	N/A	N/A	N/A	N/A	N/A
	e.3 All VCNs demonstrating that the CTS requirements have been met are approved or have been dispositioned.	X	N/A	N/A	X	X	X	X
	e.4 All Hazard Reports have been approved.	X	N/A	N/A	N/A	N/A	N/A	N/A
	e.5 The Certification Data Package is approved.	X	X	X	X	X	X	X
	e.6 NASA Crew and Ground Crew usability and human system performance, NASA Crew workload, and human error analyses have been reviewed and accepted.	X	N/A	N/A	X	N/A	N/A	N/A
	e.7 All exceptions from the requirements have been approved.	X	N/A	N/A	X	X	X	X
Production								
f. The facilities, systems, and processes to support production and assembly of the integrated space vehicle have been verified to meet the applicable specifications and drawings. Any waivers, deviations or changes from the design requirements have been approved.	f.1 NASA Insight indicates that tooling and equipment used in the manufacture and test of flight hardware is verified to meet all production requirements and tolerances.	N/A	N/A	N/A	X	X	N/A	N/A

Theme	Certification Statement	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
	f.2 NASA Insight indicates that production and assembly personnel maintain certification of critical skills.	N/A	N/A	N/A	X	X	N/A	N/A
	f.3 NASA Insight indicates that manufacturing, fabrication, storage, and transportation processes comply with the CTS design.	N/A	N/A	N/A	X	X	N/A	N/A
	f.4 NASA Insight indicates the Commercial Provider's manufacturing is in compliance with the production, assembly/refurbishment and product acceptance plans and processes.	N/A	N/A	N/A	X	X	N/A	N/A
	f.5 NASA Insight indicates non-conformance identification, tracking, and corrective action processes are documented and implemented, and that issues are returned to print or accepted as a design change, as appropriate.	N/A	N/A	N/A	X	X	N/A	X
	f.0 The facilities, systems, and processes to support production and assembly of the integrated space vehicle have been verified to meet the applicable specifications and drawings. Any waivers, deviations or changes from the design requirements have been approved.	X	N/A	N/A	N/A	N/A	N/A	N/A

Theme	Certification Statement	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
g. Reserved .								
Operations								
h. The facilities and systems to support flight articles integration, ground processing, launch, flight, and recovery of the NASA Crew and vehicle have been verified to function within the operational controls, limitations and constraints. Any exceptions from the design requirements have been approved.	h.1 NASA Insight indicates the Commercial Provider's operational supporting and enabling capabilities (e.g., final assembly, integration, and testing facilities, planning, training and mission execution facilities, equipment, documents, updated databases) necessary for nominal and contingency operations have been tested and delivered/installed at the site(s).	N/A	X	N/A	N/A	N/A	X	N/A

Theme	Certification Statement	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
i. The operational plans, products, training, and mission execution processes have been verified to meets the operational requirements. Operational controls, limitations and constraints of integrated vehicle have been incorporated.	i.1 NASA Insight indicates that Commercial Provider operational plans, processes, and procedures are consistent with the design of the flight elements and incorporate operational controls, limitations and constraints of integrated vehicle.	N/A	X	N/A	X	X	X	X
	i.2 NASA Insight indicates that a process for Commercial Provider Ground Crew and NASA Crew nominal and contingency procedures to be validated and reviewed for completeness and meets operational standards.	N/A	N/A	N/A	N/A	N/A	X	N/A
	i.3 NASA Insight indicates that a training process for Commercial Provider personnel to be trained, certified, and ready to support the launch, mission control, and recovery operations (CTS nominal and contingency) has been reviewed and meets operational standards.	N/A	N/A	N/A	N/A	N/A	X	N/A
	i.4 NASA Insight indicates that a training process for NASA Crew to be trained, certified, and ready to support the spacecraft flight operations (CTS nominal and contingency) has been reviewed and meets operations standards.	N/A	N/A	N/A	N/A	N/A	X	N/A

Theme	Certification Statement	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
	i.5 NASA Insight indicates that a training process for NASA real-time support personnel to be trained and ready to support the launch, mission control, and recovery operations (CTS nominal and contingency) has been reviewed and meets operational standards.	N/A	X	N/A	N/A	N/A	N/A	N/A
	i.6 NASA Insight indicates that Operations Management plans, real-time analysis capability, and contingency action plans have been baselined and validated for real-time operations.	N/A	N/A	N/A	N/A	N/A	X	N/A
	i.7 NASA Insight indicates that Anomaly and Lessons Learned tracking systems have been developed and are exercised per the Commercial Provider's documented processes.	X	N/A	N/A	N/A	N/A	X	N/A
	i.8 NASA Insight indicates that NASA Crew and operations personnel post-flight debriefings have been developed and are exercised per the Commercial Provider's documented processes.	N/A	N/A	N/A	N/A	N/A	X	N/A

Theme	Certification Statement	SE&I	MM&I	PC&I	SC	LV	G&MO	IP
	i.9 NASA Insight indicates that the Commercial Provider has a process to develop, verify and validate operational tools consistent with operational standards. NASA confirms operational tools are developed, verified and validated according to the process and used consistent with process and flight hardware/software.	N/A	N/A	N/A	N/A	N/A	X	N/A
	i.10 All waivers, deviations, or exceptions from the operational requirements have been dispositioned.	N/A	N/A	N/A	N/A	N/A	X	N/A